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NEW SERIES. VOL. XXXVIII.—JULY TO DECFMBER, 1913.

The Names of Contributors are printed in Small Capitals

SCIENCE

FRIDAY, J[illegible] 1913

CONTENTS

-blication and books, etc., intended for -sor J McKeen Cattell, Garrison-

A PLEA FOR CLOSER INTERRELATIONS IN OUR WORK[1]

IT is the plan of our secretary to depart from the usual symposium idea this afternoon. Instead of selecting a single topic upon the various aspects of which in turn our attention is to be focused, he has asked to have addresses on different topics, evidently with the idea that we may be led to realize more fully the diversity of interests now encompassed in Section G.

This at once suggests the problem which has been formulating more clearly each year in the field where my own chief interests lie, that of plant pathology. Most of the work in this field, at least so far as it presents the problem, is of two easily definable types, which, while in some ways widely different, nevertheless, have much in common. These are, first, the training of graduate students for professional work as phytopathologists, second, the direction of research work supported by public funds, either state or national. Outside of these two fields, we have only the limited activities represented, on the one hand, by undergraduate teaching, and, on the other hand, by research privately supported. I

[1] The paper as above published is a combination of two symposium papers read by the author at the recent Cleveland meetings, as follows: (1) "A Plea for Closer Interrelations in our Work." Read at the Botanical Symposium, Section G, December 31, 1912. (2) "Some International Aspects of Phytopathological Problems." Read at the Symposium of the American Phytopathological Society, January 2, 1913. The other papers read at this Symposium are being published in *Phytopathology*. In order to make the theme continuous, the second paper has been abridged ar modified somewhat, but without essential ch- of idea.

omit, of course, public teaching or extension service as not concerning the higher aspects of the problem.

Directing our attention, then, to these two main lines of phytopathological activity—the effective prosecution of the higher lines of research and the best professional training of graduate students—the fact is becoming increasingly clear that in both lines it is of paramount importance to recognize that the complex interrelations with other departments of botanical and allied sciences are each year becoming more intricate and vital, and the need of deliberate correlation of endeavor is, therefore, becoming more imperative. Neither in research nor in graduate training can any man live by himself or to himself alone.

Many of us, in phytopathology at least, have been undergoing a transition in relations without perhaps fully realizing its significance. We shaped out individual or institutional ideals with reference to the purely local aspect of research problems or to the educational needs of the student of the more generalized type. This has meant that in the one department of one institution, and perhaps under the leadership of one man, the student has been introduced to the various aspects of botanical science, and work upon problems of widely different types has been undertaken. The futility of this having become evident with our higher aims and the increasing complexity of our modern scientific development, we have naturally substituted the university as the unit instead of the man or the department.

This seems to-day to be the dominant ideal in American university administration and departmental organization. We wish to make each great university *complete in all its parts and wholly sufficient unto itself.* At least if we are not doing so positively, we are negatively, by not clearly ...ing any higher or better ideal.

As a matter of fact, however, we have arrived at the stage where the highest efficiency and economy in research and the best training for graduate men alike demand the clear recognition of the importance of specialization, with correlation and cooperation, not only as between men and departments, but as between institutions.[2] No one man can be the best leader in all lines. No one laboratory has the best equipment for all purposes. No one library or herbarium is likely to be kept at the highest stage of working efficiency for all botanical problems. No one locality offers the natural or artificial environment best suited to meet all of the diverse needs of a single problem. *It is, therefore, both extravagant and futile to encourage the ideal of university completeness.*

For example, take the botanical gardens in America. All are, of course, agreed as to the usefulness of the moderate-sized garden for general college uses, or of the small but highly specialized garden for individual researches. But I think every one recognizes the tremendous cost, both in money and in executive skill, which is required to organize and develop the large botanical garden, planned and maintained as a general research center. I doubt not that most will agree, therefore, that it is better for botanical research in America to have the botanical gardens at Bronx Park and St. Louis equipped and kept at the highest possible degree of efficiency, sustained by the scientific recognition and moral support of the neighboring universities, rather than to encourage the ideal of an extensive botanical garden at every university.

[2] The need of better correlation in bo... work was also strongly urged b... in his presidential address at t... ing of the American Associatio... ment of Science. See pa... volume of SCIENCE.

The same holds with other departments or their adjuncts. What we need in American university ideals to-day is clearly and definitely to substitute the idea of institutional preeminence secured by specialization for that of a uniform grade of mediocrity imposed by the attempt at all-round equipment and attainment. And whatever we say as to the abstract principle, we shall at once see, if we compare our university curricula and analyze the situation, that this is what we are more and more clearly tending toward in our institutional developments. Specialization is an essential corollary of scientific progress. This is a universal law and applies as well to institutions as to men. This being so, it follows that just in proportion as we recognize institutional specialization we must have *institutional correlation and cooperation as an avowed and approved policy.*

Let us consider what this may signify for the two lines of endeavor in phytopathology, viz., research and graduate training.

Research.—In so far as phytopathological or similar research is supported by public funds and aims to meet economic needs, as is the case with most of the research work in plant pathology, the arguments for correlation, and indeed for cooperation, are becoming increasingly pertinent and convincing. There can be no doubt that this is the only attitude morally or scientifically justifiable. But of course this is not a thing to be secured by official fiat or rule. Indeed, no definite modes of procedure may safely be formulated. Such correlation or cooperation to be properly helpful must, to a large degree, be a matter of individual initiative and personal relation [illegible] letails must in general be [illegible] workers and developed to [illegible]s of special cases as they [illegible] entally important thing, [illegible]e the way for this, is the *general recognition of the propriety of such a course and the impropriety of any other.*

This implies the idea that state or nationally supported investigations should be so correlated as either to avoid duplication or to make the duplication of the highest scientific value. Every one experienced in any degree in such work recognizes the value of duplicated and repeated investigations. These advantages must not be sacrificed. On the other hand, every one recognizes also the prevalence of the wasteful type of work which has no such worthy aim or scientific justification. The details of accomplishing this, at least in a large degree, of eliminating the bad while saving the good, will, I am sure, present no insuperable difficulties if once the right principle is generally recognized.

Let us clearly define the ideal that *the facilities of any publicly supported institution are maintained primarily for the public good.* It follows at once that the courtesies of such experimental grounds, libraries, herbaria and laboratories are to be extended to men from other institutions with the utmost freedom compatible with non-interference with local work. If this is recognized by directors of laboratories and other administrative officers, and the ideal of correlation and cooperation as opposed to competition is commended, especially to our younger men, the balance may safely be left to the individuals concerned.

Graduate Training.—The other field in which there is the need of closer interrelations, and in some degree of correlations, includes our graduate schools. If the points already made are all well established, then it follows that we should in each of our graduate schools aim avowedly at *preeminence in certain lines*, rather than a uniform degree of excellence in all line[illegible] If this is true then it follows again that a[illegible]

graduate student seeking the best should look for leadership in more than one institution.

Most of us can recall the time when American graduate students in botany were turning to Europe for their higher training. To-day, we have the satisfaction of realizing that this is not necessary. In our American universities we now have the laboratory equipment, the libraries and a share of the personal leadership. Those qualified to compare testify that our standards are at least in as high a class as those of the European universities. Without going into familiar details, I wish at once to point out, however, that the most striking difference and defect in our American training, as compared with the German, is that it involves relatively less migration of our graduate students from university to university. All must at once admit this fact and all must lament it as unfortunate.

If this is so, we should earnestly ask why it is so and how is it to be remedied. There is neither time nor necessity for full analysis of the reasons for its existence. A partial list will suffice:

1. The geographical isolation of our botanical centers.

2. The lack of more definite recognition of the importance of institutional specialization.

3. Institutional loyalty or "college spirit" with its relative magnification of institutional prominence, rather than individual leadership.

4. The financial handicap of many a graduate student and, consequently, the attractiveness of the local financial inducements, scholarships, fellowships and assistantships, which, naturally, are offered to our own best students. This has been emphasized in recent years by the rapid institutional growth coupled with the great development of laboratory courses, which combine in demanding a large number of low-priced assistants.

5. The reluctance which every departmental head, of normal human constitution, feels at sending his best men to another institution before the completion of their graduate period.

6. The natural inertia on the part of immature students, which results from the American custom of staying by one institution: *A* stays because *B* and *C* stay, and they because *D* did the year before.

7. The fact that our graduate schools are not always so organized and managed as to make such a migration easy, simple and natural. The student can readily find out how he can get in as a beginner, but it is not so easy to learn what will be his status if he transfers.

If I have listed the more important reasons for lack of migration among our graduate students, then analysis of them shows clearly that the fault lies primarily, not with our students, but with our institutional and departmental directors—with ourselves as teachers.

To correct this we should do three things:

1. Prepare to welcome and provide for the transient student, the man who comes for one year or even one semester's work, with the same definiteness and the same departmental hospitality that we do for the man who is to stay two or three years.

2. Examine the administrative machinery and see that it is so designed, adjusted and lubricated as to make migration easy; that it is convenient for the doors to be swung both ways; that the able but transient student is admitted promptly and his work properly certified [illegible] leaves; that attainments at othe[illegible] recognized at their full [illegible]

3. Finally, and hard[illegible] until the precedents [illegible]

"habit" fixed the initiative may need to come from the instructor in charge rather than from the student. It may be a difficult thing, but it may be the right thing not infrequently, to send our keenest man to some one else for a semester or a year—even though it be the last year and the degree.

INTERNATIONAL RELATIONS

In addition to our home problems there are the international aspects of these matters of interrelation and cooperation. It is gratifying to realize that in some respects these have received more definite attention, and with better results, than those between our own institutions. This is especially true as relates to the two matters of individual research and graduate training. Dr. Farlow, in his delightful address,[3] has pictured the beginnings of American botanical student migration to Europe, and the majority in almost any botanical gathering have followed that lead. This matter needs no emphasis other than an expression of the hope that we shall not let provincial pride or overesteem of the value of our material equipments lessen the tide of student migrants to Europe, although it may well be that they continue to go with somewhat different aims than in former years.

There is, however, a broader aspect of international phytopathological problems which has not had adequate general recognition. The recent passage of the Simmons bill shows that, in some degree at least, this is dawning upon our national consciousness. This very bill, however, emphasizes the necessity for studying phytopathological problems in their international relations. Two things are especially needed to this end. First, administrators as well as investigators should recognize the importance of occasional visits by the American investigator to such foreign countries as will enable him to see his problems in their foreign setting. The relation of environment to the predisposition of the host, as well as to the virulence of the parasite, can not be over-emphasized and it is often impossible for the investigator of the local problem to realize this except as he may be temporarily translocated.[4]

Even more should our administrators see from time to time how great may be the gain from temporary or permanent employment of foreign experts. This has been done in the Department of Agriculture often enough and with sufficiently favorable results to justify its further trial. But there are inherent difficulties in the appointment of foreigners to permanent government positions and, moreover, the best of foreigners of mature experience can not be thus transplanted. Neither of these difficulties, however, arises in relation to the temporary employment of foreign experts. It seems to me that the time has come when this should be done with increasing frequency. It would result not only in giving us promptly the best expert advice for immediate application, but, what is scarcely less important, would give the foreign specialist such an understanding of the American problem as would make his further investigations more broadly inclusive of American conditions and insure results proportionately more valuable to us. Every student of the history of plant pathology recognizes the gain to England directly, and to science indirectly, which came from the employment of De Bary by the Royal Agricultural Society as expert upon the problems which arose in connection with the potato disease.

[3] See page 79 of the current volume of SCIENCE.

[4] This aspect of the discussion was set forth in detail by Dr. C. L. Shear in the second paper of the symposium before the American Phytopathological Society, January 2, 1913. Dr. Shear's paper is published in *Phytopathology*, 3: 77–87, April, 1913.

Who will measure the advantage to American plant pathology could we have had a professional visit of inspection with obligation for counsel from Aderhold, when he was at the height of his understanding of German orchard pathology; or who will estimate the stimulus to our progress upon cereal rust studies could we have brought Ward to America for even a brief sojourn when he was probing deepest into their fundamentals, providing he came commissioned and committed not alone to see but to advise? Surely if exchange professorships are scientifically and economically justifiable in any field, they are in plant pathology.[5]

In closing, then, let me briefly summarize with particular reference to phytopathology. I must leave it for those whose chief interests lie in other fields to dissent if my conclusions are not generally applicable, as I myself believe they are.

The points I would make are:

1. An understanding of the complex interrelations of our subject with the various fields of science is becoming each year more difficult and more imperative.

2. Educational and investigational work, especially where supported by public funds, should be correlated as closely as practicable on the grounds of both economy and efficiency.

3. One step looking to this should be an attempt by both departmental heads and general administrators in our graduate schools to encourage and facilitate the migration of graduate students from school to school and to locate their field operations where most favorable to the progress of their work.

4. Another step in this same direction should be an attempt at better correlation in state experiment station and national agricultural department investigations, coupled with more freedom in change of location of investigators.

5. These principles apply still more broadly to foreign relations, both as to graduate students and as to mature investigators. We need not only to make it easier for our graduate students to go abroad and to encourage our mature investigators to continue to do this with increasing frequency, but especially do we need so to arrange as to secure the official visits of foreign experts, both for advice on particular problems and to secure their intelligent general cooperation in working out our American problems.

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[5] The American Phytopathological Society after discussion of these points adopted the following resolution:

Resolved, That the American Phytopathological Society, appreciating the fact that plant diseases do not heed national limits or geographical boundaries and also the evident limitations imposed upon investigations when restricted by national bounds, respectfully recommend that administrators of research institutions, whether state or national, as well as individual investigators, recognize the importance of establishing closer international relations and take such steps as may be practicable from time to time to this end, including not only more frequent visits of American investigators to foreign countries for field observations as well as research, but also the securing, either by permanent or temporary engagement, of the best of foreign experts in plant pathology.

REPORT OF THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

(1)[1] During its 1913 (Monaco) session, the International Commission on Zoological Nomenclature has held ten executive meetings.

(2) The following nine active commissioners were present: Messrs. Allen, Blanchard, Dautzenberg, Hartert, Hoyle, Jentink, Monticelli, Stejneg

[1] For convenience of reference, the paragraphs or subjects of this report are given serial numbers in parentheses, thus: (1).

ger and Stiles. In addition, Messrs. K. Jordan and the Honorable Walter Rothschild, at the invitation of the commission, attended the meetings in an advisory capacity.

(3) The following active and advisory commissioners were not in attendance: Messrs, Apstein, Dollo, Jordan (D. S.), Ludwig and Mitchell.

(4) *Death.*—It is with profound regret that the commission reports the death of one of its members, Professor Dr. F. C. von Maehrenthal, who died in 1910, very shortly after the Gratz meeting. Putting entirely aside our feeling of personal loss as insignificant in comparison with the loss that Commissioner von Maehrenthal's death means to the international zoological profession, the commission feels that it is only just to pause a moment to recall to the members of this congress the modest character of this man who gave nearly his entire professional career to aiding his colleagues in their more tedious labors and than whom it would be difficult to find, in the entire history of zoology, any man with a keener insight into the intricacies and complications of zoological nomenclature with the possible exception of Linnæus and Strickland.

(5) *Resignations.*—During the interim since the 1910 session, the commission has received the following resignations, which are herewith reported to the congress with the recommendation that they be accepted:

Dr. G. A. Boulenger (London), who declined to serve.

Dr. Louis Dollo (Brussels), who begged to be excused from service, on the ground of poor health.

The resignation of Professor Hubert Ludwig (Bonn) has been received, but as his term of office expires with the present congress no formal action is necessary.

(6) *Advisory or Temporary Commissioners.*—Through the death of Dr. von Maehrenthal and the resignations of Drs. Boulenger, Dollo and Ludwig, the commission became reduced from 15 to 11 members. As it seemed very advisable not to permit the organization to decrease in size, and as there was no method of procedure prescribed whereby vacancies were to be filled in the interim between congresses, the commission, acting in the interest of the subject, invited certain gentlemen to fill the vacancies until these could be filled by the present congress. The gentlemen in question are as follows:

Dr. P. Chalmers Mitchell, secretary of the Zoological Society of London, was invited to serve in place of Dr. Boulenger.

Professor Kraepelin, of Hamburg, was invited to serve in place of Dr. von Maehrenthal; Dr. Kraepelin served but a short time, and Professor Apstein, of Berlin, was invited to fill the vacancy.

(7) Upon reaching Monaco, the commission invited Dr. K. Jordan, secretary of the International Committee on Entomological Nomenclature, and the Honorable Walter Rothschild to sit with the commission in an advisory capacity and this has been done.

(8) Since not a single majority vote has been determined by the gentlemen in question, and therefore their temporary membership on the commission has in reality been equivalent to their serving simply in an advisory capacity, the legality of the action taken can not be questioned on the ground that these gentlemen were not formally elected by the congress. At the same time, as a matter of formality, the commission at present asks that its action in respect to the vacancies be confirmed by the congress by the adoption of the following resolution:

(9) *Resolved,* That the informal action taken by the International Commission on Zoological Nomenclature in regard to filling vacancies be approved and ratified by this ninth congress and be made formal.

(10) In order to provide for similar contingencies in the future, the Commission recommends to the congress the adoption of the following resolution:

(11) *Resolved,* That in case of vacancies in the Commission on Zoological Nomenclature by death or resignation during the interim between congresses, said commission is empowered to fill said vacancies temporarily, with the understanding that the appointees shall hold office until the vacancies in question are filled by the next succeeding congress.

(12) *Expiration of Term of Service.*—The term of service expires at the close of this (1913, Monaco) congress for the following five members of the class of 1913:

J. A. Allen, of New York; Ph. Dautzenberg, of Paris; Hubert Ludwig, of Bonn; F. C. von Maehrenthal, deceased, of Berlin, succeeded temporarily by K. Apstein, of Berlin; W. E. Hoyle, of Cardiff.

(13) *Nominations.*—In accordance with custom obtaining since the Cambridge (1898) congress, the commission, after careful consideration as to details of the work, of countries, languages, specialties, etc., herewith has the honor to submit nominations to fill the seven vacancies that will

exist upon adjournment of the present congress. These nominations are:

Class of 1919: Professor C. Apstein, of Berlin, Germany (Professor von Maehrenthal's successor in the office of Das Tierreich), *vice* Professor Louis Dollo, of Brussels, resigned.

Professor Roule, of the Paris Museum, *vice* G. A. Boulenger, resigned.

Class of 1922: Dr. J. A. Allen, of the American Museum of Natural History, New York, *vice* J. A. Allen, term expired.

Ph. Dautzenberg, of Paris, *vice*, Ph. Dautzenberg, term expired.

Professor H. J. Kolbe, of the Berlin Museum, *vice* Professor Hubert Ludwig, of Bonn, term expired.

Dr. Wm. Evans Hoyle, director of the National Museum of Wales, at Cardiff, *vice* W. E. Hoyle, term expired.

Dr. Karl Jordan, secretary of the International Committee on Entomological Nomenclature, *vice* F. C. von Maehrenthal deceased and term expired.

(14) *Proposition to enlarge the Commission.*—This commission originally consisted of five members, elected at the Leyden congress in 1895. Upon recommendation of the original commission, the Cambridge (1898) congress increased the number of commissioners to fifteen. The present commission is of the opinion that it is now in the interest of the subject to increase the membership from fifteen to eighteen with the understanding that the three new commissioners shall be so arranged that one joins the class of 1916, one that of 1919 and one that of 1922. The commission is led to this recommendation by several reasons, notably by the three following: (1) there exists at present an excellent opportunity to cooperate in work on the nomenclature of entomology and the situation is such that the commission desires the services of two additional entomologists in this connection; (2) the work of the commission has increased to such an extent that it seems in the interest of the subject to have three more men available for service; (3) the commission feels that it is desirable to return to its former policy of having a paleontologist among its members and in view of the present amount of work before us this will be difficult unless authority is given for the appointment of the additional men requested. If the congress authorizes the three additional men, the commission is prepared to make the nominations required, as follows:

Class of 1916: Dr. Henry Skinner, of the Academy of Natural Sciences, Philadelphia.

Class of 1919: Dr. Geza Horvâth, of Budapest.

Class of 1922: Dr. F. A. Bather, assistant keeper of geology, British Museum of Natural History, London.

(15) *Offers of Cooperation.*—It is a pleasure to report that two nomenclatorial committees have, since the last congress, made overtures to the commission to cooperate in work.

One offer of cooperation has come from the Committee on Nomenclature of the American Paleontological Society and consisting of Wm. H. Dall, F. H. Knowlton and S. W. Williston (secretary).

Another offer of cooperation has come from the International Committee on Entomological Nomenclature.

(16) In this connection it may be stated that a working arrangement has been made between the secretary of the International Committee on Entomological Nomenclature and the Secretary of the International Commission on Zoological Nomenclature, in accordance with which all questions on entomological nomenclature will be referred to the International Committee on Entomological Nomenclature for study as to premises and for report before any opinion on them is issued by the International Commission, and attention is invited to the fact that the secretary of the Committee on Entomological Nomenclature has been nominated for membership in the International Commission. Whether the time will ever come that the International Commission on Zoological Nomenclature will consist chiefly or exclusively of the secretaries of various international committees representing special groups remains to be seen.

(17) *By-laws.*—The commission has made no amendment to its by-laws since 1910, but attention may be invited to the fact that the president is the presiding officer and that the secretary is the administrative officer. If, therefore, any person desires to submit propositions to the entire commission, time will be saved if they are sent directly to the secretary, whose permanent address is: Hygienic Laboratory, U. S. Public Health Service, Washington, D. C.

(18) In order to avoid misunderstanding in the future, attention may be invited to the fact that the commission does not feel called upon to consider any communication addressed to it only through the medium of journals or the proceedings of learned societies. To insure consideration of communications the latter may best be sent direct

to the secretary and if their receipt is not acknowledged within a reasonable time the conclusion may safely be drawn that they were never received.

(19) *Official List of most Frequently Used Zoological Names.*—The Gratz congress adopted a recommendation by the commission to the effect that an attempt be made to establish, on basis of the International Rules of Nomenclature, an "Official List of most Frequently Used Zoological Names." In accordance with this vote, the secretary invited a number of workers to form themselves into special committees and to cooperate in the undertaking, and he submitted to several of these committees lists of names for study.

(20) The vigorous protests received from various sources were not foreseen. Some zoologists protested against the proposed list on the ground that this was the beginning of a list of "Nomina conservanda" to which they would not submit; others demanded that the secretary agree that the list be made without reference to the law of priority; some practically challenged the right of the commission to undertake the work; others flatly refused to cooperate; some agreed to cooperate and did so; others promised aid that has thus far not been forthcoming.

(21) In view of the great dissatisfaction with the proposed list, the secretary finally decided that the wisest plan would be to submit to the commission only a comparatively small number of names as a sample of what was proposed and to postpone further action on the matter until the commission might discuss the situation and lay its views before the congress for further consideration.

(22) The commission submits herewith a sample of what it had in mind in suggesting the official list. This consists of an *accepted* list of 40 generic names which appear from our present knowledge to be valid under the code and a *rejected* list of names which appear to be unavailable under the code.

(23) The commission recommends that this be taken as a beginning and that names be very gradually and carefully selected to be added to the list. It will, however, be impossible to build out this nomenclator unless cooperation is had from systematists in the different groups. With proper cooperation, however, the commission is persuaded that 100 to 500 accepted names and as many or more rejected names might be added to the list every three years and that in this way not only would we obtain a list of established names for the genera most frequently referred to but that many useless names could be definitely eliminated from literature. The commission does not desire, however, to continue this very time-consuming labor unless there is a very distinct desire on the part of zoologists to have the work done and a willingness to cooperate in the undertaking.

(24) The names suggested as samples for adoption are distributed as follows: Trematoda, 11; Cestoda, 5; Nematoda, 7; Gordiacea, 2; Acanthocephala, 1; Arachnoidea, 8; Diptera, 6. Practically all of these come into consideration not only in zoological, but also in medical and veterinary literature.

(25) Public notice has been given that these names would be called up for vote at this (1913) meeting of the commission and ample opportunity has been afforded for the presentation of objections. No objection to any name in the list as now submitted has been presented to the commission.

(26) In addition to the list of 40 names submitted for action at the present meeting, the commission submits a list of 169 generic names of birds, with their authorities, references, genotypes and method of type fixation, based on the International Rules of Zoological Nomenclature and unanimously agreed upon by a special committee of professional ornithologists, upon which the following gentlemen served: J. A. Allen (New York), E. Hartert (Tring), C. E. Hellmayr (Munich), H. C. Oberholser (Washington), C. W. Richmond, secretary (Washington), R. Ridgway (Washington), L. Stejneger (Washington) and W. Stone (Philadelphia).

(27) It is the intention of the commission to send this list of names to press in the very near future and to give ample opportunity to the zoological profession to offer objection to any of the names in question. Shortly after January 1, 1914, the commission contemplates announcing the fact whether or not objection has been raised and will issue an opinion regarding the adoption of the list. This opinion would then be laid before the Tenth International Congress for confirmation.

(28) A third list, consisting of 430 names "*to be rejected*," is submitted by the commission. These names also have been made public with invitation to zoologists to present arguments showing why any of said names should not be rejected. This list is to be interpreted simply as follows: Word has reached the commission in one form or another that these names are absolute homonyms and therefore (Art. 34) unavailable; under these

circumstances the commission will consider the names in question as stillborn unless evidence is presented that the premises now before the commission are erroneous; further, the commission suggests to authors that they cooperate in the work by either correcting the premises before the commission or by discontinuing to use the names. The "*To be rejected*" list consists thus far of 430 generic names, distributed as follows: Trematoda, 22; Nematoda, 40; Gordiacea, 1; Acanthocephala, 2; Diptera, 92; Mammalia, 273.

(29) Many other names, supposedly valid or supposedly unavailable, are still under consideration either by the commission or by the several special subcommittees, but no further work in this line is contemplated unless the present congress distinctly expresses its desire to have the labor continued.

(30) In the opinion of the commission, work of this nature is distinctly constructive and promises the ultimate possibility of an international and authoritative list of the names that should be applied to the most commonly cited 5,000 to 10,000 zoological genera.

[Here follow the lists of names. These will appear in the Proceedings of the Congress.]

(46) *Presumable Permanency of the Official List.*—That the question as to the presumable permanency of the Official List based upon the law of priority may arise in the minds of many zoologists is to be taken as self-understood. This question may be answered as follows:

(47) Changes in names dependent upon changes in conceptions of classification can not be foreseen from one generation to the next and any plan for nomenclature that ignores this point makes promises that can not count upon being fulfilled. The following statistics, however, worked out by Lester F. Ward (1895) give an indication of the changes that may reasonably be expected to occur upon nomenclatorial grounds:

(48) By taking the first 50 genera given in the American Ornithologists' Union Check-List, it is found that in only five cases did the generic name remain unchanged from 1859 to 1886. Thus prior to the establishment of the names on basis of the law of priority, 45 of the 50 names (or 90 per cent.) changed from 1859 to 1886. From 1886 (when the names were established on basis of the law of priority) to 1895, not one of the 50 names was changed. The complete list embraced 322 genera and about 1,000 species and subspecies. In the ten years following the publication of the list (based upon priority), it was found necessary to change, by action of the law of priority, the names of 3 genera, 1 subgenus, 3 species and 1 subspecies.

(49) The commission invites the serious attention of the congress to these very remarkable results obtained by the code of the American Ornithologists' Union. If our international code is properly safeguarded against changes taken hastily and without due deliberation as to the many complications involved, it may reasonably be expected that our International Official List will undergo very few changes, upon nomenclatorial grounds, but this commission can not possibly foresee what changes must be adopted during the next 10 to 100 years because of unforeseen changes in conceptions of classification.

(50) The commission has the honor to request definite instructions from the congress as to whether or not it is the desire to have this list continued.

(51) *Code of Ethics.*—The commission permits itself to invite attention to the fact that there exists in the zoological profession no recognized and generally adopted code of ethics that is comparable to the code of ethics existing in the medical profession of certain countries. Without presuming to be the arbiter of points of general ethics, the commission is persuaded that there is one phase of this subject upon which it is competent to speak and in reference to this point it suggests to the congress the adoption of the following resolution:

(52) Whereas, Experience has shown that authors, not infrequently, inadvertently publish, as new designations of genera or species names that are preoccupied, *and*

Whereas, Experience has also shown that some other authors discovering the homonymy have published new names for the later homonyms in question, *be it therefore*

Resolved, That when it is noticed by any zoologist that the generic or the specific name published by any living author as new is in reality a homonym and therefore unavailable under Articles 34 and 36 of the Rules on Nomenclature, the proper action, from a standpoint of professional etiquette is for said person to notify said author of the facts of the case and to give said author ample opportunity to propose a substitute name.

(53) *Date of Author's Reprints or Separata.*—Among the cases recently submitted to the commission for opinion is one that involves a somewhat unusual point in respect to reprints. Under the present rules there is no article which permits the commission to rule that all separata are

of the same date as, or of a later date than, the original publication, although such a proposal has now been submitted as an amendment to the rules and will be considered in time for the Tenth Congress. In the meantime, the commission has instructed the secretary to report the following resolutions to the congress:

(54) *Resolved,* That the commission, under unanimous suspension of the by-laws if need be, recommends to the congress the adoption of the following resolution, namely:

(55) WHEREAS the widespread custom of issuing reprints in advance of the appearance of the original publication gives rise to much unnecessary confusion in nomenclature, be it

(56) *Resolved,* That the Ninth International Zoological Congress expresses its disapproval of this custom and appeals to editors to discontinue it, and further, be it

(57) *Resolved,* That editors be requested to give on each edition of all publications the exact date (year, month, day) of issue of said edition.

(58) *Opinions.*—At the Boston (1907) congress the commission reported upon opinions 1 to 5 inclusive; at the Gratz (1910) congress it reported upon opinions 6 to 28 inclusive; at the present congress, it herewith reports the summaries of opinions 29 to 56 inclusive. The full opinions have been published by the Smithsonian Institution, Washington, D. C., as Publications Nos. 1938, 1989, 2013, 2060; No. 2169, containing opinions 52 to 56 inclusive, is now in proof and will soon be issued. Attention is invited to a correction of opinion 31 published on page 89, Publication No. 2060.

The commission regrets to hear that some zoologists claim to have been unable to find copies of these opinions and desires to state that they are sent to 1,100 libraries, to the members of the International Congress and to a limited number of specialists. Only the summaries are issued in the proceedings of the congress. If any member of the congress fails to receive the full opinions, he is invited to notify the secretary of the commission.

At its present session the commission has taken a preliminary or a final vote upon several additional opinions and it now has under consideration about 15 other cases that have been submitted to it for study.

[Here follow the summaries of opinions 29–56.]

(59) The opinions have now been a policy for six years. They have been received by various zoologists in different ways. Some of our colleagues in the profession are urging us to continue this policy, on the ground that it is the logical method of settling difficult questions. Others are opposed to the policy and one man has even practically challenged our right to issue the series.

(60) This commission is well aware of the fact that in issuing 56 opinions we have not been able to decide on both sides of every question and thus to please every person.

(61) It may not be out of place to remark that these opinions have recently probably been the greatest factor in pressing to the fore the law of priority and in producing discontent. Formerly, so long as two authors could not agree upon a given point of nomenclature, each followed his own interpretation. If one of these authors now submits the case to the commission, an opinion is rendered which, of course, has not the force of law, but which nevertheless is a strong moral support to one side of the controversy in question. Experience has, however, shown that instances are not lacking when the commission by giving its opinion has drawn upon itself the fire which in earlier days would have been directed to the individual worker in whose favor the opinion happens to be given. And it has come about that the commission has not been permitted to remain ignorant of the fact that it has perhaps made fewer friends than enemies in its endeavor to conform to the wishes of our colleagues to settle cases for them.

(62) The commission does not consider that in rendering these opinions it is placing itself under any obligations whatever to zoologists for the privilege of doing so much work for other people, and is perfectly willing to discontinue the series. In continuing to give opinions, however, the commission can not be expected to depart from the code and to make exceptions in order to please individual workers. If the congress is not satisfied with the results, it will be an easy matter for the congress to say so.

(63) The commission as at present constituted feels it proper, however, to remind zoologists that in the performance of our duties we are not supposed to take into consideration any personal preferences or any local, factional or personal quarrels—such as have actually been presented to us as if they were valid nomenclatorial argument.

(64) *Increasing Interest in Nomenclature.*—Probably at no time in the history of zoology has there been a more widespread interest in the subject of nomenclature than exists at present. This interest is probably due to several factors, one of which is the increased sense of necessity or at least desirability for international uniformity in use of

technical names. As authors increase in number and attempt to monograph various groups the lack of uniformity in the use of names is brought home to them, and no matter what policy they may try to follow they usually find it necessary to change some of the names more or less current in their group. Under existing rules and under all standard codes since 1845, and in spirit at least since the Linnean Code of 1751, the law of priority has in general been taken as fundamental criterion in deciding certain classes of the changes, and in fact so many points have been made upon basis of this law that it has aroused opposition from certain quarters.

(65) In this connection it is interesting to note that if an author changes from *Amœba* to *Ameba*, or from *Amœba vulgaris* to *A. princeps*, or if he makes a change of name and gives as his reason the fact that the rejected name does not please him, or even if he divides an old collective genus into 40 or 50 new genera, introducing 39 or 49 new names and retains the old collective generic name for the indefinite residuum, his action is not very likely to produce any particular indignation, but if any author consistently applies the law of priority, thus attempting to settle all cases objectively he becomes what one author is pleased to call a "fanatic priority ruler."

(66) As authors are increasing in number and as publications become so numerous, both the application of the law of priority and the protests against the law increase.

(67) The commission is distinctly gratified if its efforts have contributed in even a small degree to the present increased interest in the subject. It may, however, be permitted to invite attention to three phases of the present status of the subject which are somewhat disquieting.

(68) 1. *Intemperate Language.*—Whether or not it be an actual fact, appearances to that effect exist that if one author changes or corrects the names used by another writer, the latter seems inclined to take the change as a personal offense. The explanation of this fact (or appearance, as the case may be) is not entirely clear. If one person corrects the grammar of another, this action seems to be interpreted as a criticism upon the good breeding or education of the latter person. Nomenclature has been called "the grammar of science," and possibly there is some inborn feeling that changes in nomenclature involve a reflection upon one's education, culture and breeding. Too frequently there follows a discussion in which one or the other author so far departs from the paths of diplomatic discussion, that he seems to give more or less foundation to the view that there is something in his culture subject to criticism. It is with distinct regret that the commisson notices the tendency to sarcasm and intemperate language so noticeable in discussions which should be not only of the most friendly nature, especially since a thorough mutual understanding is so valuable to an agreement, but which are complicated and rendered more difficult of results by every little departure from those methods adopted by professional gentlemen.

(69) In the opinion of the commission the tendency to enter into public polemics over matters which educated and refined professional gentlemen might so easily settle in friendly and diplomatic correspondence is distinctly unfavorable to a settlement of the nomenclatorial cases for which a solution is sought. It may be assumed that the vast majority of zoologists agree with the commission in desiring results rather than polemics, and the commission ventures to suggest that results may be obtained more easily by the utmost consideration for the usual rules of courtesy when discussing the views of others.

(70) 2. *Education in Nomenclature.*—It may safely be asserted that comparatively few zoologists upon beginning their independent professional career have even a general idea of the subject of nomenclature, for the reason that zoological grammar (namely, zoological nomenclature) is not usually taught in courses leading to the bachelor's, the master's or the doctor's degree. Without wishing to emphasize the point unduly, the commission ventures to suggest that it would be in the interest of harmony if at least the elementary rudiments of the subject were taught more generally to students preparing themselves for a career as professional zoologists.

(71) 3. *The Immensity of the Task before Us.*—Despite the quite generally increased interest shown in the subject of nomenclature, there are some grounds for disquiet in the fact that relatively so few workers seem to grasp the immensity of the task involved in introducing harmony of system among so many different groups and in bringing about satisfactory conditions among so many hundreds of thousands of technical names scattered over so many different publications written or edited in so many instances by workers who, despite their erudition in respect to their subject, were so to speak not exactly grammatical—or at least rhetorical—when it came to their technical names.

(72) That present conditions are to be settled in a day or in a few years is not to be expected. The transitional period between the lack of uniformity in the past and the hoped-for uniformity of the future will last at least one entire generation, and to our generation falls the pleasure or the misfortune (according to one's point of view) of undertaking the extensive and distinctly altruistic duty of saving future generations of scientific workers from the dangerous inheritance of chaotic nomenclature that threatens them.

(73) Stability in *all* zoological names during our generation is not in the dreams of the members of this commission, which at your request undertook eighteen years ago a most trying, most thankless and very extensive task, for which the only reward in its successful accomplishment exists in the thought that our work is a sacrifice.

(74) That many of our colleagues should differ with us in point of view does not disquiet us, but it is a matter of some misgiving to us that some of our colleagues are (or at least *seemingly* are) of the opinion that the difficulties at hand are to be settled so easily and in a few years.

(75) The transitional period will be mentioned again in connection with the reference to the law of priority.

(76) Whatever the outcome of the present situation, the commission desires to express its gratification of the fact that, judged from the various postal card votes that have recently been taken, many persons to-day are hearing of the rules of nomenclature who probably rarely if ever heard of them before and many others are taking an active interest who formerly ignored the subject. At the same time the feeling that has been exhibited in some instances leads the commission to the view that the present occasion is one that calls for cool and calm deliberation rather than for attempts to obtain majorities in postal card votes, for surely the quiet deliberations of a few representatives selected because of their long experience in the intricacies of a very intricate subject are more likely to reduce confusion than is the conclusion of a large number of persons, voting upon a subject perhaps by mail and assuredly with less careful deliberation.

(77) This latter point was clearly recognized in the Cambridge (England) meeting when the commission was not, because of a lack of unanimity in its report, even accorded a place on the program to present the rules, and again in the Berlin congress when the commission was urged to keep the subject of nomenclature out of the general meetings by reporting only upon propositions agreed upon by unanimous vote in commission.

(78) *The Relations of the Commission to the Congress.*—Certain letters and certain published criticisms seem to indicate more or less clearly that there is considerable misunderstanding in regard to the relationship of the commission to the congress. In the hope of clearing up certain points and thus in the hope of a better understanding, the commission ventures to give a brief statement bearing on this subject.

(79) In 1889 and 1892, at the Paris and the Moscow congresses, a code of zoological nomenclature was discussed and adopted.

(80) In 1895, at the Leiden congress, a desire was expressed by one of the German delegates to have all codes submitted to a comparative study and to have the results presented to the next congress. As a result, a commission of five members was appointed to carry out this task. This commission worked for three years and was prepared to present its report to the Cambridge congress of 1898, but because of the fact that this report was not unanimous on all points, the commission was refused a place on the program for the presentation of its conclusions as to the rules. The commission was, however, increased to 15 members in the hope of reaching more satisfactory results in its vote, and upon motion the general session voted that all propositions that were to be reported upon at any given congress were to be in the hands of the commission at least one year prior to the meeting of the congress.

(81) After another period of three years' work, during which the enlarged commission had to restudy the entire report of the original commission, the former met at Berlin in 1901. Before its report was completed conferences were held with quite a number of the more prominent members of the congress. During these conferences the commission was given very distinctly to understand that the congress would not receive any report unless it was unanimous. As one prominent German member of the congress stated *in effect:* "It is the duty of the commission to become unanimous in its vote; give us a definite set of rules, good, bad or indifferent, but be unanimous in your report, and after you give us the rules, see that they are carried out." The words of this prominent German savant were a fair reflection of the feeling we found at the Berlin meeting, so far as the secretary of the commission could discover.

(82) Unfortunately the Commission could not

agree upon all points, and after many conferences, it finally suggested to the congress the proposition that those portions of the rules upon which the commission was unanimous should be accepted, and that all other portions be referred back to the commission. This motion, suggested in the general session, prevailed.

(83) After its experience at Cambridge and Berlin the commission was indeed not inclined again to repeat its action of preparing for the congress (as it did at Cambridge) any proposition unless all of its members present at the congress were unanimously agreed upon it. In order to make this point certain the commission adopted at the Berne congress the principle of reporting recommendations in regard to changes in the rules, only when the vote upon them was unanimously in the affirmative. Since the Berne congress this plan has, in the interest of conservatism, been strictly adhered to. From the Berlin congress in 1901 until the present congress, no section on nomenclature has been provided by the program committee and the commission has endeavored to meet this situation by holding an open meeting of the commission which all persons interested in nomenclature were invited to attend.

(84) The history of the commission has clearly demonstrated that the congress has thus far desired not to have its general meetings turned into open discussions on questions of nomenclature, but rather to have nomenclatorial discussions confined to sections and commissions and nomenclatorial questions decided in committee.

(85) If at present there is a change of desire on the part of the congress and if the congress wishes these very technical and complex matters discussed in the general sessions, the commission would rejoice at the more general interest in nomenclature as evidenced by such a desire, but at the same time it is constrained to state that nomenclature is a subject that requires quiet deliberation rather than formal debate, and, further, that to throw open the general meetings of this congress as a forum for this exceedingly dry and complicated subject will be not only to jeopardize the success of future congresses, but, since this plan is not in accord with the plan under which many zoologists elected to follow the international rules, a grave question arises as to following such a policy.

(86) *Amendments to the "Règles Internationales de la Nomenclature Zoologique."*—There have been fifteen series of amendments submitted to the commission which has been in session since Friday, March 22, studying the various suggestions, giving hearings, etc. For instance, a special hearing was given both to Professor Brauer and to Dr. Poche for presentation of any arguments or points of view they might desire to submit in connection with the proposed amendments in which they were especially interested.

(87) A somewhat embarrassing situation presented itself because of the unusually early date of the congress, but a valid parliamentary method was suggested under which it became possible to consider all of the propositions submitted.

(88) Departing from the usual custom, the secretary had published in the *Zoologischer Anzeiger*, November 26, 1912, and March 11, 1913, all propositions that had reached him and in addition several propositions that were known to him by fact of their publication.

(89) Under the by-laws adopted by the commission, and published for general information in the last report, the commission proceeds as follows: Under Art. IV., Section 1(*a*) the commission reports to the congress "Recommendations involving any alteration of the 'Règles Internationales de la Nomenclature Zoologique,' but no such recommendation is to be reported unless it has first received a majority (8) vote of the commission and the unanimous vote of all commissioners present at the meeting."

(90) In accordance with this by-law, the commission herewith reports upon the following amendments with the recommendations that they be inserted in their proper place in the Règles.

(91) (*a*) Suggested amendment No. 9, submitted by the First International Entomological Congress, has been modified slightly by the commission, and is reported in the following form as a *Recommendation:* "It is recommended that in published descriptions of new species or new subspecies, only one specimen be designated and labeled as *type,* the other specimens examined by the author at the same time being *paratypes.*"

(92) (*b*) Suggested amendment No. 13, submitted by J. A. Allen and T. D. A. Cockerell.—After considerable discussion, the commission voted that the first portion of the proposed amendment (concerning *Gavia, Fregata* and *Piccoides*) and the first portion of the second paragraph (concerning *Plautus*) are already covered by the Règles as interpreted by opinion 46.

(93) The idea also obtains for at least a portion of suggested amendment No. 1, that the points in question are provided for in the code, and a formal opinion to this effect is now contemplated.

(94) *The Law of Priority.*—The law of priority has been affirmed by a number of zoological codes, and has been formally affirmed twice (1892 and 1901) by the International Congress of Zoology. The original code of 1889 and 1892 permitted certain exceptions to this law. Contrary to the very earnest appeals of the president and the secretary of the commission, the section on nomenclature in the Berlin congress adopted the view that these exceptions should be eliminated and in said section the view obtained that the law of priority should be rigidly enforced *without any exceptions of any kind in any group.* When the matter came to argument in the commission, the president and the secretary after a long discussion and with many misgivings, finally, for the sake of harmony accepted the will of the majority, but this was not until after they had received positive assurance from prominent members of the congress that the commission would be supported in its attempt to carry out the amended law, for which, in the minds of the president and the secretary, the zoological profession was not then prepared. Clearly foreseeing at that date the tremendous dissatisfaction that the amended law would cause, in a profession not all of whose members are accustomed to dealing with a large number of names, the president and the secretary of this commission immediately, in part even before adjournment of the Berlin congress in 1901, made preparations to meet the discontent which to their minds was inevitable as a result of the action taken at the Berlin congress. This discontent has now culminated in the presentation to the commission of several propositions which have for their purpose the authorization of exceptions to the law of priority. From the fact that the several propositions submitted to the commission before this congress convened, and no less than four substitute propositions submitted formally or suggested informally during the present work, are very different in character, the commission is persuaded that the adherents of the policy of making exceptions to the law are far from being in accord as to the method that should be adopted. From the fact that memorials, protests, resolutions, letters, etc., both for and against the plan of exceptions have reached the commission evidence is clear that the conclusions of the International Congress of Zoology held in Berlin, Germany, are still subject to a considerable difference of opinion. The commission does not see its way clear to accept the postal card votes that have been taken as representing a sound basis upon which its decision must be made, but incidentally it may be mentioned as a matter of more or less general interest that more persons have protested to the commission against changing the rules by admitting exceptions than have asked that exceptions be made. The interpretation the commission places upon the two votes is that there is a tremendously increased interest on both sides of the subject and that there are many zoologists who feel the same inconveniences that the commission has felt ever since its organization and the same inconveniences that all zoologists have felt who have tried to consistently apply the law.

(95) Admitting without any reservation the point that the commission itself feels very keenly the inconveniences of the law, even claiming in fact that the original commission of 1895 was in favor of certain exceptions as evidenced by its report, the present personnel of the commission, whatever may be its views as to the wisdom of the action taken in Berlin, stands in overwhelming majority against admitting to the code any provision looking to exceptions to this long-established rule.

(96) The administrative office of the Deutsche Zoologische Gesellschaft, through a statement published (*Zool. Anz.*, March 11, 1913) as official by its secretary gives its view to the effect that decision on this matter should be reached during the present congress and that this decision can not be postponed for three years; furthermore, a number of members of the congress have expressed the view to the effect that this subject must now be settled definitely, finally and once for all, so that they may proceed in their work undisturbed by vacillations in the rules.

(97) So far as the question concerns the commission, the matter may be viewed as settled; and if this matter, at least in its present form, come before any future congress it will be because of the changes in the commission's personnel that occur by death, resignation and expiration of terms of service, or because it is forced upon the commission by circumstances.

(98) In this report it has been unreservedly stated that the law of priority is a harsh law and produces inconveniences. It has also been stated that the president and the secretary of the commission, when defeated in the Berlin congress in attempt to make this law somewhat milder, immediately laid plans with a view of possibly meeting the situation in some other way. The general plan discussed by them after their defeat in Berlin in 1901 has been constantly held in reserve to be

presented when the proper time should come. It is this plan, in slightly modified form, that the commission presents to the congress as basis for an attempt to relieve zoologists, more especially teachers, of at least some of the inconveniences of which complaint is made. That this plan does not go far enough to suit some members of this congress is so self-evident that it need not even be admitted. It is, however, the unanimous opinion of the commission as assembled in Monaco, that this is the most feasible method in view by which this work may be inaugurated. Prior to giving the plan in detail, it may be stated that the secretary of the commission has asked a number of zoologists to give a rough estimate as to the number of names for which exceptions were desired and also the number of names in the working vocabulary of the average zoologist other than systematists. The estimates in reply to the first question varied exceedingly, one man placing it as low as 20, others as high as 600; the estimate in reply to the latter question, as to vocabulary, usually varied from 300 to 600, although one man placed it at 1,000. This highest estimate, namely, 1,000 names, is taken as present numerical basis in the suggestion here made, namely, the adoption of the following resolution:

(99) Whereas, It is claimed that during the transitional period in nomenclature when the names are being reduced to a consistent, uniform and objective basis, hardships result to many zoologists, especially to teachers, because of the changes involved, therefore, be it

(100) *Resolved,* That the Ninth International Zoological Congress establish an "International Committee on Transitional Names," as follows:

1. No person is eligible to serve at the same time as a member of the International Commission of Zoological Nomenclature and on this new committee.

2. Said committee is to be composed of 15 zoologists who shall have power to organize in such manner as they may deem wise.

3. Said committee is empowered to select 1,000 (and no more) zoological names, in such manner and with such aid from other zoologists as the committee may desire, and is instructed definitely to define the meaning of the names selected.

4. Said list of 1,000 names is to be known as the "Transitional List" and it shall be considered proper during the transitional stage of nomenclature of any given group, for any author to use any of said names, even though they be not in accord with the law of priority.

5. All authors making use of the Transitional List are urgently requested to designate the name by a dagger (†) or by such other sign as the committee may select, in order to signify that they are using the names in the sense of the list.

6. As soon as both the International Commission of Zoological Nomenclature and the International Committee on Transitional List vote independently by a two thirds majority that the time has come in the nomenclature of any group to drop any given name or names from the Transitional List, joint report to this effect is to be made to the International Congress and the name or names in question are then to be removed from the Transitional List.

(101) *Resolved,* That this action is not to be interpreted as in any way restricting the application of the law of priority or of any other provision in the rules of nomenclature.

(102) Incidentally it may be stated that the commission has for some time had under informal discussion the advisability of a resolution by the congress placing in the hands of the commission the plenary power of suppressing entirely, in some way, certain names which it is claimed are at present applied in an erroneous sense and which when transferred to the correct genus or species under the law of priority are calculated to produce unusual confusion. As yet the views of the commission are not formulated in a sufficiently safeguarded manner to make it advisable to report definitely on the subject at the present congress. [See below, Supplementary Report.]

(103) Although the resolution as reported places in the hands of the proposed Committee on Transitional List unrestricted power as to the selection of the names, this point does not raise any misgivings in the mind of the commission. Furthermore, the resolution gives to the committee in question unrestricted privilege of inviting cooperation and it safeguards the list by requiring a two thirds majority in order to eliminate names from the list.

(104) In reference to the personnel of the new committee, the commission presents the following resolution:

(105) *Resolved,* That, for purposes of organizing, the initial members of the Committee on Transitional List shall be: Professor Brauer (secretary of the Deutsche Zoologische Gesellschaft), Dr. Mortensen (of Copenhagen) and Dr. Williston (of the University of Chicago); and

(106) *Resolved,* That these men be authorized

and instructed to complete the personnel of the committee.

(107) *A New Edition of the Code.*—The commission recommends to the congress the insertion into the proceedings of the present congress a copy of the revised code of rules, and that the summaries of opinions be printed in the appendix.

(108) Signed in name of commission.

C. W. STILES,
Secretary

(109) SUPPLEMENTAL REPORT

[(110) After the foregoing report was prepared, an additional proposition was submitted to the commission that had been adopted by the Section on Nomenclature. This proposition, however, after presentation of the foregoing and this supplemental report, the section voted to reconsider and upon such reconsideration the section approved in its place the resolutions presented in this supplemental report.—C. W. S.]

[(111) In presenting this supplemental report, the secretary made a verbal statement to the effect that these resolutions were not completed until after the foregoing report had been adopted by the commission, hence they could not be included in the regular report. They were in fact not completed until the morning of the last day of the congress. Prior to the meeting of the Section on Nomenclature, most of the members of the commission had approved the resolutions, and the section took a recess in order to permit the other commissioners to consider them. All commissioners approved the resolutions and the secretary was instructed to present them to the section and the congress as a supplemental report. From a parliamentary point of view, they are accepted by the commission as addition to the subject discussed in paragraph (102) of the report and as substitute for several of the proposals that had been presented as amendments to the code. The subject matter was first presented to the commission during its Gratz meeting, and since that time has been under more or less consideration. It was discussed during the Monaco (1913) meeting of the congress, but the form of the proposition was not agreed upon until immediately prior to its presentation at the joint session of the commission and of the Section on Nomenclature.—C. W. S.]

(112) The commission unanimously recommends to the congress the adoption of the following resolutions:

(113) *Resolved,* That plenary power is herewith conferred upon the International Commission on Zoological Nomenclature, acting for this congress, to suspend the Règles as applied to any given case, where in its judgment the strict application of the Règles will clearly result in greater confusion than uniformity, *provided,* however, that not less than one year's notice shall be given in any two or more of the following publications, namely, *Bulletin de la Soc. zoologique de France, Monitore zoologico, Nature,* SCIENCE (New York) and *Zoologische Anzeiger,* that the question of possible suspension of the Règles as applied to such case is under consideration, thereby making it possible for zoologists, particularly specialists in the group in question to present arguments for or against the suspension under consideration; and *provided,* also, that the vote in commission is unanimously in favor of suspension; and *provided* further that if the vote in commission is a two thirds majority of the full commission, but not a unanimous vote in favor of suspension, the commission is hereby instructed to report the facts to the next succeeding International Congress; and

(114) *Resolved,* That in the event that a case reaches the congress, as heretofore described, with a two thirds majority of the commission in favor of suspension, but without unanimous report, it shall be the duty of the president of the Section on Nomenclature to select a special board of three members, consisting of one member of the commission who voted on each side of the question and one ex-member of the commission who has not expressed any public opinion on the case, and this special board shall review the evidence presented to it and its report, either majority or unanimous, shall be final and without appeal, so far as the congress is concerned; and

(115) *Resolved,* That the foregoing authority refers in the first instance and especially to cases of the names of larval stages and the transference of names from one genus or species to another; and

(116) *Resolved,* That the congress fully approves the plan that has been inaugurated by the commission of conferring with special committees from the special group involved in any given case, and that it authorizes and instructs the commission to continue and extend this policy.

ACTION OF THE SECTION ON NOMENCLATURE AND OF THE CONGRESS ON THE FOREGOING REPORTS

At the Saturday morning session of the Section on Nomenclature the chairman gave the floor to the secretary of the Commission on Nomenclature. The secretary invited attention to the fact that the

by-laws of the commission provided for an open meeting of the commission, and he moved that the present session of the section resolve itself into a joint meeting of the commission and of the section, in order to comply with the provision in question. Upon second, this motion prevailed.

The secretary reported that he was under instructions from the commission to present to the meeting the report and a supplemental report of the commission. The chair called for the reports which were read in full, except that upon motion, second and vote, he read paragraphs (31–45 and 58) by title, or by title and examples.

Following the reading of the regular report, the meeting took a short recess to enable certain members of the commission to examine and vote on the supplemental report. After the meeting was again called to order, the supplemental report was read.

The secretary requested the adoption of the reports as a whole, explaining that this adoption did not carry with it the approval of the separate recommendations. Upon motion, and second, the reports were adopted.

The secretary requested action on those paragraphs that involved recommendations, nominations and resolutions. Acting upon each subject separately, the joint meeting, upon motion and second *approved* the following paragraphs separately:

(5), (9), (11), (13), (14), (50) [commission instructed to continue the list], (52 *a, b, c*) [vote unanimous except for one], (55), (56), (57), (91), (107), (113), (114), (115), (116).

The secretary was asked if it would be agreeable to him to resubmit the names in (31), (32), (33), (34), (35), (36) and (37) to subcommittees of specialists before they were formally approved. His reply was that the suggestion was entirely agreeable, and he withdrew his request for formal approval of these lists.

The secretary gave notice that the list of bird genera in (38) would be published before action was taken by the commission.

No formal action was asked upon (40), (41), (42), (43), (44), (45).

In view of the fact that opinions 29–51, inclusive, had been printed in detail, it was moved, seconded, and voted that the section (58) of the report dealing with opinions 29–56 be read by title, and that the opinions be approved.

Commissioner Stejneger stated that he now had some misgivings as to whether or not practical difficulties might arise in coordinating the resolutions of paragraphs (99), (100), (101), (105), (106) with (113), (114), (115) and he requested that action on the former be postponed until the next congress, in order to determine more clearly whether the two propositions contained anything of a contradictory nature. As any one commissioner has a right to cause postponement of action on any portion of the report (since the commission's vote must be unanimous), Dr. Stejneger's request was respected and no final action was taken in regard to the Transitional List; these sections were tabled.

In reply to certain questions, the secretary explained the following English parliamentary expressions:

"*To table*" or "to *lay on the table*" any motion means that final action is postponed upon the matter in question. Matters that are "tabled" may be "*taken from the table*" for further consideration and for final action.

The expression "*suspend* the Règles" in the supplemental report is used in its accepted parliamentary sense. Parliamentary procedures are carried out under recognized or special "parliamentary rules" and under provisions contained in "constitutions" and "by-laws." Upon a unanimous vote, by-laws may be temporarily "suspended," that is to say, they may be set aside and the body takes action on the matter under consideration unrestricted by the provisions of the by-laws, and such action, if taken under a "special rule" framed for the case at hand or without reference to any rules, except the "constitution" and recognized "parliamentary rules," has all the validity of an action taken under the "by-laws."

Thus, if the congress confers upon the commission the plenary power to suspend the Règles in any given case, it practically says to the commission: "If you carry out the precautions provided for in the supplemental report, you may decide any given case arbitrarily without reference to the Règles or you may make a "special rule" to govern that particular case, and this congress will accept your decision as being just as authoritative as if you had made your ruling strictly in accord with the code." A plan of this kind is thoroughly in accord with recognized parliamentary customs and it has the great advantage of saving the necessity of introducing "exceptions"[1] to the rules.

[1] To make this point as to the difference between "exceptions" and "suspension" of rules clearer to some of the non-English-speaking members, the secretary later used this comparison upon adjournment of the meeting:

In reply to a question, the secretary stated that a number of special committees had been formed, consisting of specialists in various groups, and that the general policy had been adopted to confer with these committees upon questions and cases affecting their particular groups. Despite the experience that this method added greatly to the routine of the secretary's office, he felt the policy should be not only continued, but also extended, and he was willing to accept, without confirmation by the section, any special committees chosen by any general committees appointed for that purpose.

In conclusion, the secretary invited attention to the fact that during part of the meeting the secretary of the section had been obliged to be absent from the session, and he therefore moved that the edited copy of the reports, with his marginal notes as to action taken, be accepted as the minutes of the joint meeting. Upon second, this motion prevailed.

C. W. STILES,
Secretary of Commission

At the afternoon general session, the secretary of the commission reported in English upon the resignations, nominations, amendments and resolutions, recommended by the commission, and approved by the Section on Nomenclature, but he did not read the report in full.

The president of the commission gave a résumé of the subject in French, translating most portions of the resolutions verbatim, and adding certain explanatory remarks.

All matters involved were voted upon by the general session, *en bloc* and without discussion (which it had been decided should be confined to the meeting of the section). Against only four dissenting votes, all the subject matter in question was adopted and approved.

C. W. STILES,
Secretary of Commission

"It would be dangerous to make a law read:

"'Theft shall be punished by imprisonment for one to ten years, *except* in such cases where the thief has tuberculosis.' But justice is tempered with mercy if one law reads:

"'Theft shall be punished by imprisonment for one to ten years,' and if another law reads:

"'The President (or the King) is empowered to *suspend* punishment in certain cases in which, in his judgment, a feeling of humanity demands such a suspension.'

"Suppose, now, it is shown that a thief, who is sentenced to ten years imprisonment, is about to die of tuberculosis; even if the sentence is passed upon him, the President (or the King) could parole or pardon the man in order to permit him to go home to die."

APPROPRIATIONS FOR THE UNIVERSITY OF ILLINOIS

ON June 24 Governor Dunne signed senate bill 675 carrying an appropriation of $4,500,000 for the University of Illinois for the biennium 1913–1915.

A correspondent writes:

The signing of this bill by Governor Dunne is one of the most important events in the history of higher education in Illinois.

First of all the passing of this bill indicates that the legislature approved by an overwhelming vote the mill tax for the university which was passed by the preceding legislature, so that all the leading parties, democrats, republicans, progressives and socialists, have endorsed this policy with unanimity. It indicates, too, the high-water mark of the whole history of educational development in the state.

In the second place it marks an epoch on account of the particular form in which the bill was passed since it leaves to the judgment of the board of trustees, within certain broad lines, the use of funds in the development of the institution and puts a stop to tendencies shown in nearly all legislatures to interfere unduly with the management of the institution by itemizing appropriations which have the effect often of thwarting the very purpose for which they were given.

The people of the state are to be congratulated that the university has never entered into politics and that all parties have had an active part in its development. The university was founded under a republican administration, but it was in the régime of a democratic governor—Governor Altgeld—that it received its first large appropriation. It was a republican administration that passed the mill tax, but a democratic one that has made it permanent and initiated a new form of passing the appropriation that marks a new era in the institutional development.

The present legislature has definitely settled another important question—one upon which for years there has been much discussion. In the university bills that were first introduced this year there was an item calling for $100,000 a year for the support of medical education. A determined

attempt was made in the senate to amend the bill to the effect that no cent of the appropriation should be used for the support of a medical college. The amendment was turned down by a vote of 34 to 9. A similar amendment in the house was defeated by the decisive vote of 94 to 37.

The trustees, therefore, who are chosen by the people, are left with the authority to spend $100,000 more or less, as it may in their best judgment seem wise, for the support of medical education. There is every reason to think that the trustees will be conservative in the carrying out of the duties entrusted to them by the people of Illinois.

SCIENTIFIC NOTES AND NEWS

DR. VICTOR C. VAUGHAN, professor of hygiene and physiological chemistry in the University of Michigan, and dean of the department of medicine and surgery, was elected president of the American Medical Association at the recent Minneapolis meeting.

AT the closing session of the meeting in Minneapolis of the Society for the Promotion of Engineering Education, Dean Anthony, of the Tufts Engineering School, was elected president. The next annual meeting will be held at Princeton, N. J.

THE Cannizzaro prize of $2,000, founded by the late Dr. Ludwig Mond, has been awarded by the Accademia dei Lincei, of Rome, to Mr. Frederick Soddy, F.R.S., lecturer in physical chemistry at the University of Glasgow, for his researches in radioactivity.

THE University of Michigan has conferred the doctorate of laws on Dr. Roscoe Pound, professor in the Harvard Law School, the author of contributions to plant geography, and the degree of doctor of public health on Surgeon General Rupert Blue.

PROFESSOR ALFRED E. BURTON, professor of topographic engineering at the Massachusetts Institute of Technology and dean, has been given the degree of doctor of science by Bowdoin College, from which he was graduated in 1878.

THE University of Cincinnati has conferred upon Dr. L. A. Bauer, of the Carnegie Institution, the degree of doctor of science.

THE University of Pennsylvania has conferred the degree of doctor of science on Mr. Witmer Stone, curator of the Academy of Natural Sciences of Philadelphia and editor of *The Auk.*

THE University of Vermont has conferred the degree of doctor of science on Mr. Chas. A. Catlin, chemist of the Rumford Chemical Works, Providence, a graduate of the university in 1872.

DR. WILLIAM J. MAYO, of Rochester, Minn., has been elected foreign correspondent of the Academy of Medicine in Paris.

PROFESSOR DMITRI PETROVITSCH KONOVALOFF, of St. Petersburg, and Professor Alfred Werner, of Zurich, have been elected honorary foreign members of the Chemical Society of London.

PROFESSOR S. A. MITCHELL, of Columbia University, has been appointed director of the Leander McCormick Observatory at the University of Virginia, as successor to Professor Ormond Stone. During the past year Dr. Mitchell has been on sabbatical leave from Columbia and has spent his time at Yerkes Observatory in the photographic determination of stellar paradox and in spectrographic investigations of motion in the line of sight.

THE board of scientific directors of the Rockefeller Institute for Medical Research announces the following appointments and promotions: The following assistants have been made associates: Frederick Burr LaForge, Ph.D. (chemistry); James Bumgardner Murphy, M.D. (pathology and bacteriology); Gustave Morris Meyer, Sc.D. (chemistry), and Martha Wollstein, M.D. (pathology and bacteriology). Michael Heidelberger, Ph.D., has been promoted from fellow to assistant in chemistry. The following new appointments are announced: Wade Hampton Brown, M.D., associate in pathology and bacteriology; Carroll G. Bull, M.D., assistant in pathology and bacteriology; Frederick Lamont Gates, M.D., fellow in physiology and pharmacology. Dr. G. Canby Robinson, formerly associate in medicine, has been appointed associate professor of medicine at Washington University,

St. Louis. Dr. Jacques J. Bronfenbrenner, formerly assistant in pathology and bacteriology, has been appointed director of the pathological laboratory of the Western Pennsylvania Hospital, Pittsburgh. Dr. Richard Vanderhorst Lamar, formerly associate in pathology and bacteriology, has been appointed professor of pathology at the University of Georgia.

PROFESSOR ROBERT R. BENSLEY, of the department of anatomy in the University of Chicago, has been made one of the editors of the *Internationale Monatsschrift für Anatomie und Physiologie,* published in Leipzig.

DR. GEORGE FAY GRACEY, professor of chemistry and toxicology in the University of Texas, has resigned to enter practise in New York as a specialist on diseases of the eye.

H. N. CONOLLY, formerly field agent in horticulture of the Alabama Polytechnic Institute, has accepted a position in the United States Department of Agriculture, Bureau of Plant Industry.

MR. A. R. HINKS, F.R.S., chief assistant at the Cambridge Observatory, and university lecturer in surveying and cartography, has been appointed assistant secretary of the Royal Geographical Society.

MR. L. G. HUNTLEY, of the Associated Geological Engineers, is at present engaged in a study of the Pelican Portage gas field and other localities in central Alberta for the city of Edmonton.

FREDERICK ANDEREGG, professor of mathematics at Oberlin College, has been granted a year's leave of absence, for study and travel in Europe.

MR. PAUL C. MILLER and Mr. M. G. Mehl have returned from a two-months' expedition in the Red Beds of Texas, the fourth into that region by the paleontological department of the University of Chicago.

MR. G. N. WOLCOTT, who is the traveling entomologist supported by the Porto Rico Sugar Growers' Association, is collecting parasites of the white grub, to introduce into Porto Rico, where the white grubs are a very serious pest in the cane fields. Mr. Wolcott has his chief headquarters in the United States at the University of Illinois.

DR. W. D. MAWSON, who is in charge of the Australasian Antarctic Expedition, which is now working on the Antarctic continent, south of Australia, has sent a wireless message to Professors David and Haswell, of Sydney, asking them to arrange for Mr. E. R. Waite, curator of Canterbury Museum, Christchurch, New Zealand, to report on the fishes of the expedition. Last year Mr. Waite joined Dr. Mawson's vessel, the *Aurora,* in an exploring expedition in the Southern Ocean, touching at the Macquarie and Auckland Islands, and obtained a number of specimens of fishes. He is now working on these, and further specimens will be sent to him from Adelie Land. Mr. Waite also reported on the fishes for Sir Ernest Shackleton's expedition in the *Nimrod.*

A STATUE of Lord Kelvin was unveiled on June 19 in the Botanic Gardens, Belfast. The chancellor of the Queen's University, Belfast, the Earl of Shaftesbury, presided and Sir Joseph Larmor, M.P., F.R.S., delivered an address. The statue is the work of Mr. Bruce Joy. We learn further from *Nature* that the statue of Lord Kelvin erected by the contributions of his fellow-citizens in Glasgow and the west of Scotland has been placed in position by the side of the new Kelvin Avenue, which traverses the Kelvingrove Park beneath Gilmorehill, close to the University of Glasgow. The statue will be unveiled on October 8 next, by the Right Hon. A. Birrell, lord rector of the university, and an address on Kelvin will be delivered by the Right Hon. A. J. Balfour, Gifford lecturer in the university. The Kelvin memorial window in Westminster Abbey will be unveiled on July 15.

AT the twenty-fifth reunion of the class of 1888 of Washington and Jefferson College, on June 17, a library memorial fund was established in honor of Dr. Jesse W. Lazear, U.S.A., a member of the class, who left before graduation to study medicine and who afterward became a member of the commission to investigate the rôle of the mosquito in the trans-

mission of yellow fever, and sacrificed his life to the cause of scientific research.

Professor N. H. Alcock, professor of physiology in McGill University and the author of important contributions to this science, has died at the age of forty-two years.

Dr. Forbes Winslow, who founded the British Hospital for Mental Disorders and was the author of numerous works on insanity, has died at the age of seventy years.

Sir Jonathan Hutchinson, a prominent London surgeon, died on June 23, aged fifty-four years.

The University of Montana Biological Station will be open from June 17 until September 1, under the direction of Dr. Morton J. Elrod, head of the department of biology. The laboratory is located on the east shore of Flathead Lake, at an altitude of 2,900 feet, in a tract of 87 acres of virgin forest donated by congress. Two other tracts of 40 acres each are on islands but a few miles distant. The Mission range of mountains come quite abruptly to the lake at the station, rising to an elevation nearby of 8,500 feet. A few miles to the south the elevation is 10,000 feet. The lake is 30 miles long and at the middle, where the station is located, it is 19 miles wide. It covers nearly 400 square miles, has a shore line of almost 150 miles and is 300 feet deep. Up the lake from near the station a fringe of fruit ranches borders the lake. Down the lake and for many miles beyond, the country is an unsettled forest. Eastward the unbroken forest extends across range after range until the plains country is reached beyond the main divide. The station was established in 1899, and has continued with an interruption of two years. Its former location was at Bigfork, where Swan River enters the lake at the upper end. Last year a building was erected. This is a two-story brick structure, capable of accommodating about 25 workers. The staff and workers live in tents, and meals are provided at a mess table. The facilities for work are extended to elementary and advanced students and to investigators. Those attending the station may take such work as they please within certain limits, and all the assistance possible will be rendered them. The field method is largely employed. Courses will be offered in botany, zoology, ecology, physiography, ornithology, entomology, photography and plankton, besides the facilities offered for research.

According to an advance statement by Ernest F. Burchard, of the United States Geological Survey, the total quantity of Portland, natural and puzzolan cements produced in the United States in 1912 was 83,351,191 barrels, valued at $67,461,513, compared with 79,547,958 barrels, valued at $66,705,136, in 1911. This represents an increase in quantity of 3,803,233 barrels, or 4.78 per cent., and in value of $756,377, or 1.13 per cent. The distribution of the total production among the three main classes of cement in 1912 is as follows: Portland, 82,438,096 barrels, valued at $67,016,928; natural, 821,231 barrels, valued at $367,222; puzzolan, 91,864 barrels, valued at $77,363. The total production of Portland cement in the United States in 1912, as reported to the United States Geological Survey, was 82,438,096 barrels, valued at $67,016,928, compared with 78,528,637 barrels, valued at $66,248,817, in 1911. The output for 1912 represents an increase in quantity of 3,909,459 barrels, or nearly 4.98 per cent., and in value of $768,111, or 1.13 per cent. The shipments of Portland cement from the mills in the United States in 1912 are, according to reports received by the survey, 85,012,556 barrels, valued at $69,109,800, compared with 75,547,829 barrels, valued at $63,762,638, shipped in 1911. The shipments therefore represent an increase in quantity of 9,464,727 barrels, or 12.52 per cent., and in value of $5,247,162, or 8.38 per cent. The average price per barrel in 1912, according to these figures, was a trifle less than 81.3 cents, compared with 84.4 cents in 1911. This represents the value of cement in bulk at the mills, including labor and cost of packing, but not the value of the sacks or barrels. The average price per barrel for the country is about 13.9 cents higher than the average price received for Portland cement in the Lehigh district, where it was sold at the

cheapest rate, and is near the average price received in the Iowa-Missouri district, but it falls 54.5 cents below the average price received on the Pacific coast, where Portland cement brought the highest figure during the year.

UNIVERSITY AND EDUCATIONAL NEWS

THE University of Chicago has received $300,000 for a building to be used as a social center and gymnasium for the women of the university. The donor is Mr. La Verne Noyes. The building is to be a memorial to his deceased wife and will be known as the Ida Noyes Hall.

AT the recent commencement at Smith College, it was announced that the trustees had appropriated the sum of $140,000 for the construction of a new biological building.

DR. E. P. LYON, professor of physiology and dean of the Medical College of St. Louis University, has been appointed dean of the medical department of the University of Minnesota and director of the physiological department.

CHARLES S. WILLIAMSON, JR., associate professor of chemistry in the Alabama Polytechnic Institute, has accepted an associate professorship of industrial and sugar chemistry in Tulane University.

F. E. CHIDESTER, Ph.D. (Clark), instructor at Rutgers College, has been advanced to the position of assistant professor of biology.

THE department of zoology at Oberlin College will be enlarged during the coming year by the addition of Professor Charles G. Rogers, formerly of Syracuse University.

PROMOTIONS and new appointments at the Johns Hopkins University include the following: In the philosophical faculty: J. Elliott Gilpin, Ph.D., now associate professor, to be collegiate professor of chemistry; Duncan S. Johnson, Ph.D., now professor of botany, to be professor of botany and director of the Botanical Laboratory and the Botanical Garden; Burton E. Livingston, Ph.D., now professor of plant physiology, to be professor of plant physiology and director of the Laboratory of Plant Physiology; Edward W. Berry, now associate in paleobotany, to be associate professor of paleontology; Joseph T. Singewald, Jr., Ph.D., now Henry E. Johnston scholar, to be associate in economic geology. In the medical faculty: Leonard G. Rowntree, M.D., now associate, to be associate professor of experimental therapeutics; Warren H. Lewis, M.D., now associate professor of anatomy, to be professor of physiological anatomy; E. V. Cowdry, M.D., of the University of Chicago, to be associate in anatomy; Dr. Paul G. Shipley, of Yale University, and Dr. George Corner, to be assistants in anatomy.

FOLLOWING the creation of the new office of chancellor at Leland Stanford Junior University to be filled by Dr. David Starr Jordan and the appointment of Dr. J. C. Branner, to the office of president, Dr. John Maxson Stillman, head of the department of chemistry, has been made vice-president. The following promotions and appointments in the university faculty have been made: In the sabbatical absence of Professor H. W. Stuart, in philosophy, Professor Warner Fite, of the University of Indiana, has been elected acting professor for the first semester. Assistant Professor George Holland Sabine, in the same department, has been made associate professor. In economics, Instructors Stephen Ivan Miller and Donald Frederick Grass have been made assistant professors. In graphic art, H. V. Poor has been appointed assistant professor. In mathematics Associate Professor H. F. Blichfeldt has been made professor, and Assistant Professor W. A. Manning, in applied mathematics, has been made associate professor. Instructor L. E. Cutter, in mechanical engineering, has been made assistant professor. In physiology, Instructor F. W. Weymouth has been made assistant professor. In medicine, Assistant Professor Thomas Addis has been made associate professor, and Instructor E. D. Congdon has been made assistant professor. Instructor Leo Eloesser has been made assistant professor of surgery.

AT Birmingham University Professor W. S. Boulton, professor of geology at University

College, Cardiff, has been appointed to succeed Professor C. Lapworth, F.R.S., who retires at the close of the present year.

Professor Abderhalden goes to Vienna as the successor of Professor Ludwig, to take charge of the Institute for Medical Chemistry.

A chair of exotic pathology has been established at the Collège de France. The assembly of the professors of the college has submitted for the choice of the ministry, Dr. Nattan-Larrier as their first choice and Dr. Tanon as their second choice for this chair.

DISCUSSION AND CORRESPONDENCE

SOME FACTS CONCERNING MENDELISM

In the *American Breeders' Magazine,* No. 1, Vol. 6, there is a short sketch of the life of Thomas Andrew Knight. Attention is drawn to the fact that Mr. Knight gave to the Horticultural Society of London, in 1823, the results of some experiments that he had carried on in cross breeding peas. Following this statement Mr. Knight's reason for using peas is given, and it is remarked as peculiar that he was using the same plants, as Mendel later did, in breeding experiments and discussing these experiments a year after Mendel was born. Consulting the original paper of Mr. Knight's in the proceedings of the Horticultural Society for 1823, a reference was found to another paper in the same volume of proceedings which was written in 1822, the year Mendel was born. The author of this second paper was Mr. John Goss. It seems that Mr. Goss had been cross breeding the Prolific Blue pea and a dwarf pea and had obtained some results which he thought worthy of publicity.

In part the article of Mr. Goss is as follows:

> In the summer of 1820 I deprived some blooms of the Prolific Blue of their stamina and the next day applied the pollen of a dwarf pea, of which impregnation I obtained three pods of seed. In the following spring when these were opened, in order to sow the seed, I found to my great surprise, that the color of the peas instead of being deep blue, like their female parent, was of a yellowish white, like the male. Toward the end of the summer I was equally surprised to find that these white seeds had produced some pods with all blue, some with all white, and many with both blue and white peas in the same pod.
>
> Last spring I separated all the blue peas from the white, and sowed each color in separate rows; and I now find that the blue produces only blue, while the white seeds yield some pods with all white, and some with both blue and white peas intermixed.

It would seem from the above that Mr. Goss had a great law within his hands, but because of the fact that the first three pods of seeds seemed to show direct effect of pollen he lost sight of the very thing that was later stated as a law, and continued his paper as a discussion of direct effect of pollen in the first impregnation.

Following immediately the paper of Mr. Goss's in the proceedings is a note by the secretary of the society referring to a communication of one Alexander Seton, Esq., which was read before the Society on August 20, 1822. It seems that Mr. Seton made a similar experiment to that of Mr. Goss, with the following results: Mr. Seton impregnated the Dwarf Imperial, a green variety of pea, with the pollen of a white, free-growing variety. From this pollination he obtained only one pod, which contained four peas, and which did not differ in appearance from the others of the female parent. The plants that grew from these four peas seemed to partake of the nature of both parents, being taller and more profuse than the Dwarf Imperial and less so than the male white parent, and the pods resembled those of the former, being short and having but few peas in each pod. On their ripening it was found that instead of their containing peas like those of either parent or of an appearance between the two, almost every one of them had some peas of the full green color of the Dwarf Imperial and others of the whitish color of the other parent. They were, however, found in undefined numbers in the pods, and all of the peas were completely of one color or the other, with none having an intermediate tint, as Mr. Seton had expected. Accompanying these two papers and opposite page 273 of volume 5 of the transactions of the Horticultural Society of London, pub-

lished in 1824, there is found a plate showing one of the pods produced by Mr. Seton. This colored plate shows two green peas and three white ones in the same pod.

It is interesting to note how close these men came, in the year of his nativity, to the law which later made Mendel famous.

T. H. McHATTON
COLLEGE OF AGRICULTURE,
UNIVERSITY OF GEORGIA

THE FOOD OF PLANTS

DR. BENEDICT in a recent number of SCIENCE opens the question regarding the definition of the word food as used by botanists.

That we need to come to some agreement is, I think, generally felt by teachers in all grades of the subject.

If we have in mind the plant's relation to substances outside of itself which may be taken and used in any of its vital processes, then carbon dioxide, water and minerals are food. This notion was suggested by the animal organism, which, however, is essentially unlike a plant in respect to immediate external relations. The term plant food arose to emphasize the importance of certain mineral constituents of the soil. Its use ignores the green plant's unique place in nature, and by implication even denies it.

If on the other hand we have reference to growth and repair of living tissue, carbon dioxide, water and minerals are waste products, the antithesis of food.

The question resolves itself into this, to which concept of the plant's activities is the concept food most nearly related? If the answer is nutrition then only such substances as can be oxidized in the tissues and energy thereby set free, are foods. To answer the question otherwise is not only to invite trouble from such a term as reserve food, but worse, make the whole subject of metabolism impossible of presentation. If we write the words "energy stored" and "energy set free" in the equations for photosynthesis and for respiration, the term food, in its commonly accepted sense is clear, and the term as applied to inorganic matter an absurdity. Nevertheless, the term plant food as applied to nitrate of soda, etc., is with us to stay, just as surely as oysters will continue to be known as shellfish.

It is our business to fit pedagogic methods to the facts and see that fundamental truths are clearly set forth regardless of how many qualifying terms we must employ.

I forbear quoting sentences from text-books in which the term food is used in opposite senses without explanation, thus by implication denying the importance of photosynthesis and ignoring the law of conservation of energy. Hypercriticism is born of pedantry, but consistency is a jewel. The agriculturist can not use our term fruit and we can not use his term plant food without contradiction and confusion. The trouble is not so much one of definition as of usage. A Frenchman who was learning English said: "When a horse goes rapidly you say he is fast, and when you tie him to the post he is fast. Your language is very difficult."

H. N. CONSER
UNIVERSITY OF MAINE,
May 27, 1913

A GOOD SOIL TUBE

GLASS tubes are generally used in soil physics laboratories when carrying on experiments on capillary rise and distribution of water in soils. To give the best results these must be one and one half to two inches in diameter, and are expensive and fragile. In student laboratories with class numbering 100 or more the writer has had an annual breakage of over 75 per cent.

During the past year a new style of tube has been used in the soil technology laboratories at the University of California. This form was suggested to the writer by Professor E. O. Fippin, of Cornell, and is in use there and in other laboratories.

The tubes consist of a wire-mesh cylinder, two inches in diameter and of the desired length, made by wrapping one fourth inch mesh wire netting around a form and riveting the edges at intervals of six or eight inches. Celluloid tubes made of thin transparent sheet

celluloid, cut in strips seven or eight inches wide, and rolled into cylinders, are thrust into the wire tube. This makes a cylinder that is soil-tight, transparent and durable. With reasonable use it will last several seasons, though the celluloid may crack or become scratched and opaque. They prove very satisfactory for capillary rise experiments and are excellent for studying distribution of water, as the inner tube can be withdrawn and unrolled, exposing the soil for easy sampling.

CHARLES F. SHAW
UNIVERSITY OF CALIFORNIA

LEE'S "INTRODUCTION TO BOTANY"

TO THE EDITOR OF SCIENCE: For a particular purpose I wish much to see a copy of James Lee's "Introduction to Botany," published in London in 1760, the first edition. I have inquired, but in vain, of all the large libraries in the United States, though all of them have later editions. Can any reader of SCIENCE tell me where a copy may be found in this country?

W. F. GANONG
SMITH COLLEGE,
NORTHAMPTON, MASS.

THE LEONHARD EULER SOCIETY

IT is well known that in 1909 the Swiss Naturforschende Gesellschaft resolved to publish the works of the extremely prolific and famous mathematician Euler. The estimated cost for the complete edition of over 40 large quarto volumes was supposed to be approximately $100,000 and was covered by about 400 subscribers (25 francs per volume, or $80,000 by subscription) and the so-called Euler-Fund resulting from contributions of governing bodies, scientific societies, industrial establishments and private persons.

So far six volumes have appeared and a seventh is in press. The work is apparently very carefully edited, and the typography is perfect.

Unfortunately the experience gained by the publication of the first volumes and the fact that a large number of additional papers and letters recently found among the documents of the Imperial Academy of St. Petersburg and in various other places will increase the total number of volumes show that the original estimate of cost is not nearly enough to guarantee a successful completion of the entire undertaking.

In order to partly meet an expected deficit of $40,000 it is proposed to found a *Leonhard Euler Society* with unlimited membership. The annual dues will be 10 francs (about $2) and membership is merely an honorary obligation to contribute to the success of a great scientific enterprise.

The originality and importance of Euler's writings, even at the present time, make it very desirable to have a uniform edition of all his works and it is so hoped that the appeal of the Swiss society will be generously answered by scientific circles.

ARNOLD EMCH
UNIVERSITY OF ILLINOIS

SCIENTIFIC BOOKS

Fixité de la Côte Atlantique de l'Amérique du Nord. By DOUGLAS W. JOHNSON.

The quite harmonious interpretation of coast-level changes along the American Atlantic, made by scores of clean-witted and experienced observers through scores of years, are here briefly scrutinized and fundamentally contested. The supposed ups and downs of the Atlantic coast, which have been so carefully and abundantly recorded from Gaspé to the Carolinas, had promulgated a widely accepted notion that the North Atlantic seaboard was very uneasy, still undergoing warpings which might well have been in direct inheritance of its ancient Appalachian instability. Dr. Johnson's paper under the above title is not quite new, its date being rather more than a year back, but in these prolific and harlequin days of scientific ideas, it takes a little while for the leaven of reformation to register its effect. There are many excellent reasons for not taking grave exception to Dr. Johnson's general conclusion that the eastern American land is as a whole in fairly stable equilibrium—that is to say, is not now

in the act of swinging through the vertical secular period which the diastrophism of geological change calls for. Nevertheless, the first impulse of the local observer, let us suppose a geologist perfectly familiar with the undeniable indications of elevation or submergence within his own Atlantic field, is to resent this conception and conclusion of general present stability as too lightly putting aside factors of very positive significance.

The theorem is one of no little moment. Either the Atlantic coast is dancing up here and down there, as the Philistines have declared, bringing alternate hope and despair to riparian owners, or else it is standing flat and firm. We have learned that the uneasiest thing in the earth is the earth itself, the very philosophy of terrestrial equilibrium precludes the notion of too long stability or of an end to the rhythm of vertical vibration. So we may, probably we must take this notion of stability as one limited to an inappreciable change through the "present," the "historic" period, at all events one of brevity, and this is of course a different proposition than one of actual stability. I am of those who frankly resented Dr. Johnson's general conclusions, for my records are sufficiently profuse in what seemed best construed as local warpings. This was my attitude at a first reading of this and his other papers on this subject. A fallow interval and a second reading have led me to subject my data of apparent land rise and fall to his suggested treatment—to look at each by itself as a possibly localized effect of storm and stress against the coast, involving now and again the burying of woodlands, undermining and poisoning of forest growth by salt water, etc., and I am disposed to think that very many of the cases I am most familiar with on the Gulf of St. Lawrence coast may be resolved by such measures; and that, as the author himself has said, the absence of continuity in these destructive effects intimates their local character. Professor Ganong has recently suggested, concerning effects of this kind noted by him in New Brunswick, that it may be well to take record of the changes in the head-of-tide in seaboard streams. This would be an interesting procedure, but even here there is a chance for large error; granted that if the historic records of head-of-tide were trustworthy, such variables as the scouring of freshet streams and the stress conditions from off the sea must both be estimated.

There lies a large value in these conclusions of stability, though I confess to little enthusiasm over some of the procedure by which the conclusion is reached. It may be a new geographical principle that assumes differences in high level between the waters of a barachois and those of the open sea from which it is severed by a bar gullied with tidal tickles; and the vigorous attack by quiet and sheltered barachois waters against their bounding land, even when the gale blows hardest, is rather too leonine for general belief.

The geologist, in considering such facts, will not forget that in dealing with the north Atlantic seaboard, we are facing a rias coast; in other words, the ocean forces, under prevailing winds, strike the anticlines and synclines of Appalachian land, head on, beating against their ends, not their flanks. They are playing at the greatest advantage in downbreaking ridges and overwhelming valleys. In fact, in many places in the northeastern and St. Lawrence lands the waters of the new bays lie in the old synclines of the paleozoic. Under such conditions of long-continued turmoil and attack where the tide can rush with immensely increased volume and impetuosity, at greatest destructive advantage, in among the ancient troughs, there is a vast chance for the production of conditions which might on the one hand suggest subsidence where poisoned forests are left by the retreat or lodging of the salt waters, and on the other intimate elevation, as the water level in times of reasonable quiescence lies below the field of its destruction in time of stress.

If one will leave the debatable ground of the coast itself and take to the continental islands, such as Prince Edward Island and the Magdalens, the evidence of present stability is fairly beyond stricture. The Magdalens are more particularly to the point as

they are far in the heart of the gulf, away from any recent entanglement with the mainland, which is not quite so true of Prince Edward Island. Here is a cluster of rock fragments knit together by sand bars which show no single trace or semblance of recent elevation or depression. Even the broad dune-covered bars patched with stunted spruce and dune-grass afford no indication of tree burial or poisoning by encroachment of the water without or of the great lagoons within. The rocks of the islands are rather homogeneous in quality, except for the volcanics. The sandstones are retreating rapidly under the wave attacks, and while the volcanics stand out in better resistance, the broad submarine platform about the islands is uniformly smoothed. The soundings of the admiralty chart show how uniform the smoothing has been. The five-fathom platform ties all the islands of the Magdalens proper into one. The walrus bones heaped together on the top of the low horizontal rock shelves where they were left by the hunters more than a century ago, lie as they lay then, only coated with a century of soil and quietly falling away into the sea as the waters gnaw down the rocks. The five-fathom level is approximately a true wave platform, but the ten-fathom level, which outlines a platform of a hundred times the present superficies of the surviving islands, is unquestionably a wave-cut level deeply submerged. In this ten-fathom level there is no appeal from the evidence of a submergence at a time not far back of the present or from the conclusion that the Magdalens are mere interwoven shreds of a once great island, but we must not be pressed to declare how long ago the negative movement ceased. Not long, probably; but for this day, this present, we lack the right to say that there is any movement in process, up or down. A clue is suggested as to the length of this actual stability; facing the great interior lagoon bounded by the double chain of sand bars are ragged rock cliffs, with bare faces that never could have been torn by the feeble waters of the lagoon even in times of tempest. These cliffs, now enmeshed by sand and facing only placid waters, were made ragged and bare in the days when the sea itself pounded at their base. Since then the whole network of sand has been built up about them, and yet all this without any definite indication of change of water level.

JOHN M. CLARKE

Einführung in die Mathematik für Biologen und Chemiker. Von Professor Dr. LEONOR MICHAELIS, Privatdozent an der Universität Berlin. Verlag von Julius Springer, Berlin. 1912.

It is the purpose of this book to bring before the chemist and the biologist, in convenient form, some mathematical information that is necessary to an understanding of methods that are being used more and more in chemistry and biology. The first chapter of the book gives a recapitulation of some very elementary mathematics, including plane geometry, the most elementary algebra and trigonometry. The second chapter is given to the study of some very simple functions such as are usually treated in a first course in analytic geometry. The main part of the book is given to the calculus, to differential equations, and to applications to chemistry and physics.

The author has succeeded in bringing a large amount of useful material into a small space, and the book will perhaps serve well its purpose. Although the reviewer recognizes that, in an elementary book, one may sacrifice too much simplicity for the sake of precision in the statement of fundamentals, there is some danger that the chemist and biologist will get incorrect views as to the precision of the processes of differentiation and integration when presented as they are in this book. To illustrate, on p. 107, we find the statement

$$\sin\frac{dx}{2}=\frac{dx}{2}$$

and analogous statements are to be found at many points in the book.

I note the following numerical and typographical errors: Line 23, p. 37, should contain 0.7071 instead of 0.7069, and line 9, p. 107, should have

$$\frac{\sin \pi/2}{\pi/2} = \frac{1}{1.57}$$

instead of

$$\frac{\sin \pi/2}{\pi/2} = \frac{0}{1.58}.$$

In carrying out his purposes, the author has very properly included a brief treatment of exact and inexact differentials, Fourier's series, and the application of imaginary numbers to the solution of some differential equations that are important in mathematical physics.

The final chapter of the book is devoted to directions for the representation of experimental data by mathematical functions, but the presentation is so brief that it is doubtful if the biologist or chemist could carry the directions into numerical effect without more mathematics than is given in this book.

On the whole, the author has shown good judgment in the selection of material for his purposes, and the biologist and chemist not familiar with the calculus will find the book of value.

H. L. RIETZ

Radioactive Substances and Their Radiations. By E. RUTHERFORD. Cambridge, University Press. 1913. Pp. vii + 700. Price, $4.50.

The subject of radioactivity is now just sixteen years old, yet the volume of its literature already compares favorably with that of any of the other grand divisions of physics and two compendious text-books, Rutherford's and Madame Curie's—not to mention a host of less pretentious treatments—are available to initiate the student into its mysteries.

It is now eight years since the second edition of Rutherford's "Radioactivity" appeared, and in view of the fact that this period covers one half of the life of the science, it is scarcely to be expected that its present status could be adequately presented by a mere revision of that book. And it is to the author's credit that he has not attempted to patch the new material into the old frame, but has instead built an entirely new framework and merely utilized the old lumber wherever it still proved serviceable.

Out of a total of 700 pages, only about 150 are taken from the former work. Despite this fact, the present book makes very much the same impression as did its predecessor, whether it is given merely a cursory glance or whether it is made the subject of careful study. This is because the big problems of radioactivity were correctly solved at the start, and that largely by Rutherford himself. It is one of the most notable facts connected with this notable subject that within eight years of the discovery of the first radioactive rays, the phenomena of radioactivity should have been so thoroughly worked out and so unerringly interpreted that scarcely a viewpoint then taken in a book of 560 pages needs, after eight more years of exceedingly active experimenting, to be discarded.

The differences between the old book and the new are to be found not so much in method of treatment or in order of presentation, as in the incorporation of the new material which has accumulated within the past eight years. Much of this material has grown out of researches conducted in Rutherford's own laboratory. The additions have come chiefly from the careful study of the following subjects, none of which are found in the old text.

1. The range of the alpha particle, the law of its scattering in passing through matter, and the stopping power of substances for it. Through studies in these fields has come a great addition to our knowledge of the nature of the atom and the character of radioactive changes.

2. The phenomena of recoil, undiscovered when the old book was written, but recently diligently studied and shown to be invaluable as a means of separating radioactive products.

3. The methods of directly counting the alpha particles, one of which, namely, the scintillation method, has recently been of great help in the study of the short-lived products.

4. The scattering and change in velocity of the Beta rays in passing through matter and the remarkable resolution into a large number of homogeneous components of the Beta rays emitted by Radium *C*—studies which have thrown new light on the nature of the atom.

5. The connection between the Beta and the Gamma rays, the recent investigation of which has raised new and interesting questions regarding the nature of electro-magnetic radiation itself.

6. The elaborate study of the thorium and actinium series of products, a study which has been chiefly responsible for the extension of the twenty radioactive products known in 1905, to the thirty-two known in 1913.

7. The new evidence for and against the activity of ordinary matter.

8. The bearing of radioactivity upon the age of the earth.

The author's style is always direct and simple and the present book, like its predecessor, can be read by those not trained in severe mathematical analysis. At the same time, the work of compiling has been carefully and thoroughly done, the references to the original articles are complete, and the author has been remarkably successful in dealing fully and fairly with the work of other investigators and in making a thorough and complete presentation of the facts and theories of radioactivity as they stand in the year 1913. This book will undoubtedly be the standard work on radioactivity for the next five or six years at least.

R. A. Millikan

University of Chicago,
Ryerson Physical Laboratory,
June 2, 1913

SCIENTIFIC JOURNALS AND ARTICLES

The April number (volume 14, No. 2) of the *Transactions of the American Mathematical Society* contains the following papers:

J. L. Coolidge: "A study of the circle cross."

W. W. Denton: "Projective differential geometry of developable surfaces."

K. P. Williams: "The solutions of non-homogeneous linear difference equations and their asymptotic form."

A. B. Coble: "An application of finite geometry to the characteristic theory of the odd and even theta functions."

W. F. Osgood and E. H. Taylor: "Conformal transformations on the boundaries of their regions of definition."

The May number (volume 19, number 8) of the *Bulletin of the American Mathematical Society* contains: Report of the February meeting of the Society, by F. N. Cole; "Three or more rational curves collinearly related," by J. E. Rowe; "Second note on Fermat's last theorem," by R. D. Carmichael; "An extension of a theorem of Painlevé," by E. H. Taylor; "Mathematical physics and integral equations," by W. A. Hurwitz; "Shorter Notices": Schulze's Teaching of Mathematics in Secondary Schools, by J. L. Coolidge; Hime's Anharmonic Coordinates, by J. V. McKelvey; Beutel's Algebraische Kurven, Zweiter Teil, by H. S. White; Scheffer's Lehrbuch der Mathematik für Studierende der Naturwissenschaften und der Technik, by A. R. Crathorne; Sainte-Laguë's Notions de Mathématiques, by R. C. Archibald; Weber and Wellstein's Encyklopädie der Elementar-Mathematik, Band III., by J. B. Shaw; Whittaker's History of the Theories of the Æther and Electricity, Krause's Theorie der elliptischen Funktionen and Mill's Introduction to Thermodynamics, by E. B. Wilson; Annuaire du Bureau des Longitudes pour l'An 1913, by E. W. Brown; "Notes"; "New Publications."

The June number of the *Bulletin* contains: Report of the spring meeting of the Chicago Section, by H. E. Slaught; "Concerning two recent theorems on implicit functions," by L. L. Dines; "Concerning the property Δ of a class of functions," by A. D. Pitcher; "The asymptotic form of the function $\Psi(x)$," by K. P. Williams; "An erroneous application of Bayes' theorem to the set of real numbers," by E. L. Dodd; "Shorter Notices": Weber's Partielle Differential-Gleichungen der mathematischen Physik, Band II., and Föppl's Theorie der Elektrizität, Band I., by J. B. Shaw; "Notes"; "New Publications."

SPECIAL ARTICLES

ACCESSORY CHROMOSOMES IN THE PIG

Several points of interest were brought to light in this study of the spermatogenesis of the pig and the relation of the accessory chromosomes to sex. Unusually good material was available for this investigation and it was found that eighteen chromosomes occur in the

spermatogonia. Two of these, undoubtedly the accessories, are oval in shape and somewhat larger than the others, which are rod-shape.

In the primary spermatocytes ten chromosomes appear in the late prophase of division, eight large bivalents plus the two unpaired accessories. In the metaphase of this division the accessories pass to one pole, undivided, and in advance of the other chromosomes. Thus, this division which is evidently the reduction division gives rise to two different types of secondary spermatocytes. The one type contains eight ordinary chromosomes or autosomes, and the other eight autosomes plus the two accessories.

In the late prophase and early metaphase of division in the secondary spermatocyte four large chromosomes appear in the one type of cell and four plus the two accessories in the other. Thus a second fusion of the autosomes in pairs has evidently taken place. This is not to be looked on as a second reduction division, however, as the autosomes in the late metaphase of division in these cells manifest their bivalent nature again. The secondary spermatocytes containing the four large chromosomes give rise to two spermatids each with four bivalents or eight univalents; and those containing the four large chromosomes and the two accessories give rise to spermatids containing four bivalents or eight univalent chromosomes plus the two accessories which have divided here for the first time since the last spermatogonial division.

The spermatids transform directly into spermatozoa. The conspicuous centrosome emerges from the sphere and divides into two parts which for some time remain connected by a thick strand of material. The anterior centrosome comes in contact with the nuclear wall while the posterior one becomes transformed into a ring through which extends the developing axial filament. In the meantime the sphere migrates around the nucleus to a point opposite the anterior centrosomes where it becomes fixed as the acrosome. Long before the axial filament is fully developed the posterior ring-shaped centrosome is thrown off and lies in the cytoplasm away from the axial filament. During the final development of the spermatozoan a large mass of cytoplasm containing the posterior centrosome is thrown off by the cell. Careful measurements of a large number of the mature spermatozoa show that they are of two distinct types, one being much larger than the other.

The investigation was extended to studies of the germinal and somatic cells of both male and female pig embryos. It was again found in the male that the spermatogonial number of chromosomes is eighteen and that the same number prevails in the somatic cells, two of the chromosomes being somewhat larger. Twenty chromosomes, four somewhat larger and evidently the accessories, were found in the oogonia, and the same number prevails in the somatic cells of the female. It is evident that the eggs containing the reduced number of chromosomes, which is ten, when fertilized by the one type of spermatozoan containing ten chromosomes give rise to individuals containing twenty chromosomes in their cells, or females; while those fertilized by the other type containing only eight chromosomes give rise to individuals with eighteen chromosomes in their cells, which was found to be the number in the male.

Many investigators have found a similar dimorphic condition in the number of chromosomes in the two sexes of some of the invertebrates; and although the same condition was predicted to exist in the vertebrates possessing the X-element, it has, heretofore, never been actually shown.

N. E. Jordan in a recent abstract[1] says that the heterochromosomes are unquestionably lacking in the pig and several other mammals. Since the appearance of this article I have carefully reinvestigated my material and am thoroughly convinced that my conclusion is correct. A detailed account of this investigation will be published later.

J. E. WODSEDALEK

ZOOLOGICAL LABORATORY,
UNIVERSITY OF WISCONSIN,
January 30, 1913

[1] SCIENCE, N. S., Vol. XXXVII., No. 946, pp. 270–271.

THE EFFECT OF EXTERNAL STIMULI UPON THE CELL

The structure of the trophoplasm is an expression of the physiologic state. This structure consequently varies with the changing functional phases of the trophoplasm. Thus, in the root tip of *Vicia faba* the trophoplasm in the later stages of inanition becomes homogeneous; under the influence of antipyrine it becomes beautifully alveolar; under the influence of caffein it becomes granular; and in cells subjected to high pressure it becomes filar. The quantity of the trophoplasm is reduced as the cell activities are increased above the normal. Thus, in cells exposed to temperatures of 38 degrees Centigrade the trophoplasm is greatly reduced in quantity, and may appear not unlike the trophoplasm in advanced stages of inanition. A similar reduction is noticeable when cells are subjected to two-per-cent. solutions of antipyrine. On the other hand, cells subjected to low temperatures—zero degrees Centigrade to + 2—the cell activity is reduced and the trophoplasm increased in quantity. The same is true, though to a less extent, when cells are subjected to a two-per-cent. solution of chloral hydrate.

The kinoplasm is physiologically and morphologically distinct from the trophoplasm. It is destroyed at temperatures near zero degrees Centigrade and at 38 to 40 degrees. The trophoplasm endures these temperatures for a considerably longer time, with little or no injury. Chemical agents, like chloral hydrate, readily destroy the kinoplasm with little or no injury to the trophoplasm. The nucleolus varies in size, being large when the cell activity is greatly reduced and small when the cell activity is greatly increased. It is to be looked upon as reserve food material for general cellular activity. It is not food material solely for kinoplasm, nor does its substance penetrate the trophoplasm and thus activate or produce the kinoplasm.

It is difficult or impossible to explain the behavior of the mitotic spindle under the different stimuli, physical and chemical, with many of the theories now held in regard to spindle mechanism as a function.

C. F. Hottes

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE SECTION G—BOTANY

The session of Section G, Botany, was held at Cleveland on the afternoon of Tuesday, December 31, 1912. The program consisted of the address of the retiring vice-president, Professor F. C. Newcombe, on the topic "The Scope of State Natural History Surveys," and of the following invitation addresses: "The Effect of External Stimuli upon the Cell," Professor C. F. Hottes; "A Plea for Closer Interrelations in our Work," Professor L. R. Jones; "A Field Study of Oriental Cycads," Professor C. J. Chamberlain. Professor Newcombe's address has appeared in Science, and the invitation addresses will also be published in Science.

Professor Henry C. Cowles was elected vice-president of Section G for the following year, and Professor W. J. V. Osterhout was elected secretary for five years. Professor F. C. Newcombe was elected a member of the sectional committee for five years. Professor C. E. Allen and Professor B. E. Livingston were chosen as a special committee to consider affiliation with the Botanical Society of America.

Henry C. Cowles,
Secretary

BOTANISTS OF THE CENTRAL STATES

A special business meeting of this organization was held in connection with the meetings of the American Association for the Advancement of Science at Cleveland, Tuesday, December 31, 1912. In the absence of the president, Professor T. H. Macbride, Past-president Professor F. C. Newcombe occupied the chair. The business of the meeting was to consider the desirability of again holding scientific sessions. The secretary read the results of a questionnaire that had been sent to the members, and in view of the large majority favoring active continuance, it was voted to hold meetings in the future in those years when the American Association for the Advancement of Science meets outside the territory of the Botanists of the Central States, which, broadly speaking, is the Mississippi Valley. Of those expressing an opinion, a majority favored holding meetings in conjunction with the zoologists, preferably about Easter.

Henry C. Cowles,
Secretary

SCIENCE

FRIDAY, JULY 11, 1913

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

UNIVERSITY EDUCATION IN LONDON[1]

PROBABLY no document of greater importance to medical education, and to university education in general, has appeared in recent years than the report just issued by the Royal Commission. This commission, appointed by Edward Seventh, considered the organization and extension of the various institutions of higher education in London to constitute the new University of London. Its reports and extensive supplements have been published from time to time, and the parts which deal with medical education have been followed with interest by medical men in both Great Britain and America.

The appointment of the Royal Commission was not the beginning of the movement for reform of the educational institutions in London; it was rather the culmination of a long agitation which arose from several motives supported by different bodies and persons. It was only after the failure to secure the support of the university senate and convocation that the alternative course of applying directly to the crown for a charter establishing a new university altogether was adopted. The movement which led to this petition arose from the medical teachers who applied for a charter empowering them to confer degrees. From the point of view of university reform there was not much to be said for a proposal for substituting one examining body for another with the express

[1] Final report. T. Fisher Unwin, London, W. C. 1913. Price 2 shillings. The article was prepared as a review of the report of the commission, but in view of the importance of the subject and its interest to American men of science, it is printed as a leading article.—EDITOR.

object of providing a degree upon easier terms. Teaching and examining for degrees had long been separate functions in London, and it is clear that the Royal Commission deemed it of first importance that these functions be united in a single body, the university faculty.

Now the final report, which is a bulky volume, includes recommendations for the organization of the University of London with nine faculties. After discussing the present organization of the university, the essentials of a university in a great center of population are considered. As to the student, he should be young and should devote his entire time to his studies. A considerable amount of leisure is essential for independent reading, for common life with fellow students and teachers, and above all for the reflective thought necessary to the rather slow process of assimilation. University knowledge should be pursued not merely for the sake of information to be acquired, but for its own extension and always with reference to the attainment of truth. This alters the student's whole attitude of mind. Scientific thought becomes a habit, and almost incidentally intellectual power is developed.

The higher work of the university should be closely connected with the undergraduate work, on the one hand, and with research, on the other. Teaching and research should be combined; the university teacher should be an investigator. The greatest evil which results from the present organization of the university is that now this is not the case, and it is this which is most important to remove in the interest of higher education in London. The commission does not think it possible to get the best men as professors, if they are in any way restricted from doing their highest work, or are prevented from spreading their net wide to catch the best students. Research should not be exploited in the interest of individual capitalists, but should be a part of a great university.

The various independent schools in London, University College, King's College, technical schools, medical schools, etc., are to be blended in the new University of London, administered by various boards, so that they may give automatic rule, as is the case in Edinburgh, Oxford and Cambridge. It is a complex organization, much like that of our national government, and decidedly different from that of our American universities.

The university is to have complete control of everything relating to its work—property, organization, teaching and examinations—as is the case at Harvard, Columbia or Chicago. In its organization the constituent parts fall into faculties and departments, and there will also be schools. No institution should become a constituent college in any faculty unless it is able to provide a full course for the first and higher degrees awarded by that faculty. A university department deals with a single subject or group of studies of less range than a faculty. Its teachers would have the same standing as other university teachers of similar status, and its students would rank with students of a constituent college. Institutions which are independent but which are well equipped for the work they undertake, with a suitable staff of teachers, may become schools of the university.

In a university college or department, the teachers must be of university rank, that is, they must be actively engaged in research and in teaching. This is the key to the entire situation, and is referred to again and again in the report. The teaching should be suited for adults; it should be scientific, detached and impartial in character. It should not fill the minds of

the students with facts and theories, but it should call forth his own individuality and stimulate him to mental effort. He should become accustomed to critical study of leading authorities with occasional reference to first-hand information, and thus implant in his mind a standard of thoroughness and a sense of the value of truth. He then learns to state fairly the position of those whose conclusions he most stoutly opposes. He gains an insight into the conditions under which original research is carried on, which enables him to weigh evidence, follow and criticize argument and put his own value on authorities.

The commission then recommends the formation of faculties of arts, science, technology, economics, medicine, law, theology and music out of the existing institutions in London. Whether this is practicable is not for us to discuss, but their recommendations of necessity include a consideration of the whole university problem, and this they do in a masterful way. The tone of the report is the best, and for this reason it should be considered carefully by all American educators, especially at this time when our universities are under fire. In this review I shall confine myself to the part on medical education—and largely to the clinical side—as it has become the question of first importance in America. One fourth of the report, which is unanimously adopted by the commission, is devoted to medical education. What follows is largely verbatim.

In the case of the faculty of medicine, as in the case of other faculties, the commission considers what steps it is necessary to take in order to place the best teaching upon a real university basis. They can not, however, deal with the faculty of medicine on exactly the same lines they have followed in the case of other faculties, such as those of arts and science. In these faculties the provision for teaching of the highest university standard may be deficient, but the standard itself is not questioned.

In the case of the faculty of medicine there is no test to apply; except as regards pathology and hygiene the university has not attempted to determine which of the teachers of the subjects classed as advanced medical studies are entitled to the status of professors. The university could not do so under its existing regulations for the conferment of those titles, because none of those teachers fulfil the requirements with regard to salary, time and other conditions of employment. What is more significant, it is denied that the university ought to do so. So far as clinical teaching is concerned, another standard has been set up in the past. The university professor, according to the conception of the commission of him, can give instruction of the highest university standard only if he is actively engaged in the systematic advancement of knowledge in his subject. But in the case of medicine it is contended by many physicians that whether for university or other students the best teachers are men who are engaged in the practise of their profession, and have at most only as much time for original research as remains after the demands of their practise have been met.

The teaching of the intermediate subjects, anatomy, physiology and pharmacology, should be of the highest university standard, and should be provided in institutions closely related to the clinical departments.

The question of the reform of clinical teaching was first definitely raised before the commission in the evidence given by Mr. Abraham Flexner. They had received his report on medical education in the United States, and they had been informed

that he was preparing a similar report on medical education in Germany, France and Great Britain. This report received their careful consideration.

The fundamental principle underlying Flexner's argument is that university teaching can be given only by men who are actively and systematically engaged in the advancement of knowledge in the subject they teach. And this, of course, is a principle upon which the commission has insisted strongly in dealing with the general question of the essentials of university teaching, and the position and duties of the university professors.

But what is suggested and insisted on is that if, as is admitted, cooperation is necessary for the practise of medicine at the level of medical science to-day, it is also necessary, even in a higher degree, for the advancement of medical science beyond its present stage; further, that his cooperation does not exist in the hospital medical school, and can not do so as long as the physicians make use of science only to aid them in recognizing and curing disease, and in teaching their students to do so on the basis of existing knowledge. It is maintained that they must give their time to attacking the problems of disease, and that they can not do so alone, but must become members, and controlling and directing members of a group of men working together for a common end—a group in which the subordinate members are selected with a view to the special knowledge required to aid and supplement that of the leading and directing mind. They must devote themselves to original research under the conditions which make it productive in the case of the exceedingly complex problems which medical science has to solve. Finally it is said that the hospital unit is the kind of organization which experience has already shown provides the conditions required; and that it is only when the conditions have been found and established which make research in medical science possible and actual that the true university spirit will inform the teaching, and that the teachers will be the kind of men the commission have spoken of as university professors—men who will do for medicine what other men do for physiology and chemistry, and, indeed, for every subject which is capable of being scientifically treated. If this kind of teaching is essential, it seems to the commission clear that it can not be expected of men who are largely engaged in private practise; not only would the teaching and preparation for it make too great a demand on their time, but it is the kind of teaching which can really be successfully undertaken only by men whose main occupation is original research in the science of their subject.

Further in the opinion of the commission the University of London ought not to be satisfied with the present clinical teaching in the London medical schools. It appears to them beside the point to say, as some witnesses do, that the time for training is not the time for research, that a man has enough to learn then in order to make himself a good doctor, and that the leisure for research comes afterwards when he has taken his degree. It is not suggested that the undergraduate should engage in research in the medical faculty more than in any other, but that is no reason why he should not receive a university education. The commission has made it clear in the earlier part of the report—(*a*) that university education can be given only by university teachers, and (*b*) that it is a necessary condition of the work of university teachers that they should be systematically engaged in original work. Again, it is said that a good deal of scientific teaching is done by the present teachers,

although they are in active practise. Fortunately, there are always exceptional men who succeed in doing things which the conditions of their life and work make difficult for most; but it is necessary to consider what conditions are conducive to the end in view and likely to promote its attainments as the general rule and not as the exception. Having regard to the growing complexity of the subject of medical science, it seems to the commission that it will become more and more difficult as time goes on, for the really scientific teaching in the subject to be given by men whose powers are largely required for the arduous work of medical practise, and whose minds are quite rightly occupied for the most part with exacting claims and daily anxieties of their professional work. It is not conclusive that many eminent British physicians and surgeons have in the past made important contributions to the advancement of knowledge in this subject. It is doubted if it can fairly be claimed that the representatives of British medicine make their proper contributions to the scientific literature of the subject to-day, and although admirable work is still being done, it is all a matter of individual effort, and generally carried out under difficulties. But quite apart from this it makes all the difference in the world to the students of a university whether they have received a purely professional training or a university education in the course of which they will come into contact with the fringe of their subject, and will realize that it is a subject which is growing—that they can even play their part in making it grow.

The above summary from the report shows that the excellent and courageous studies on medical education by Flexner are being considered in Europe as well as in America.

After Flexner testified before the commission a number of eminent clinicians, including Sir William Osler and Professor Friedrich von Müller, gave their opinions on hospital organization and clinical teaching. The conditions prevailing in Munich were fully set forth by Müller, and Osler formulated an ideal plan based largely upon the German clinic. Osler's hospital unit for each of the important clinical branches comprises about sixty beds, various clinical laboratories, an out-patient department, and a director with a suitable staff. The principal teachers in clinical medicine and surgery in all the branches ought to be university professors in the same sense as the principal teachers in chemistry or physiology in a university. Under these conditions Osler thinks that we can expect the professor of medicine to carry out his three-fold duty; namely, curing the sick, studying problems of disease and teaching his students. Thus it is clear that American influences are making themselves felt in England. The recommendations of Flexner and Osler are adopted in practically every detail by the commission. To what extent the clinician should carry on private practise is quite definitely stated by the commission, conforming much more with Flexner's recommendation than with Osler's.

While it is conceded that the medical student should measure up to the university standard, it is also insisted upon that he should be taught by university clinical professors who are active in research.

Another matter to which the commission refers is the question whether, and to what extent, the professor should be prohibited by the terms of his appointment from engaging in private practise. One of the advantages of private practise is said to be that men gain in this way experience of human nature which is of great value in the

cure of the sick. It must be remembered, however, that the university professor of clinical medicine is not the less a physician because he is a man of science, and he acquires much of his knowledge in his treatment of the sick, although it may be admitted that the social range of his experience will be to some extent limited if it is confined to hospital work. The commission is inclined to think that the student whose sympathy is aroused by the condition of the hospital patient, irrespective of his social station, is the man who will work best under the conditions of private practise.

The experience of human nature, valuable though it may be, is not the only or even the chief advantage of private practise. To a limited extent, at any rate, it is said, on good authority, to be of scientific and professional value for the following reasons:

First, it trains the physician to distinguish with great accuracy between serious diseases and trifling ailments. The patients in the wards of a hospital have gone through a sifting process before admission, and the physician may generally assume that an admitted case is a case of serious illness, and his diagnosis is very much influenced by this knowledge. He may have to determine whether a patient is suffering from ulceration of the stomach, let us say, or it may be from cancer; but it does not matter much to the patient at the moment whether it is the one or the other. He is treated as seriously ill, and the treatment is such that even if the true diagnosis is not reached at once no great harm is done. But in private practise the great majority of cases that come before a doctor are cases of trifling ailments, and he is in danger of making fatal mistakes. If nine out of ten patients who complain of frequent internal pain are suffering from indigestion there is danger of failing to diagnose cancer in the tenth case, and the delay resulting from the mistake may be fatal. Experience of this risk leads to more careful observation and finer discrimination of symptoms. Secondly, it is in private practise that a physician has opportunities for the scientific observation of the earlier stages of disease. In the case of most patients admitted to the hospital the earlier stages are past, and the physician only hears the description of a case given by the patient himself, or by the general practitioner who has attended him. In both these cases, however, it is the general practitioner who acquires the kind of experience described, rather than the consulting physician, who is at present the hospital teacher. On the other hand, if the out-patient department of a general hospital is properly and seriously made use of, it affords great opportunities for acquiring this kind of knowledge and experience.

However, private practise has a tendency to make the physician consider the patient more than the disease, and for this reason it is of benefit to the teacher of medicine, and therefore he should not be prohibited from engaging in it to a certain extent. The amount of private practise would be limited by the work he had to do in the hospital together with the claims on his time by his own research if he were the right sort of a man. Of course there would be urgent cases which might be difficult to disregard. The commission meets this difficulty as follows:

One way of dealing with a call of this kind is to attend it only if the case appears to be one in which the professor is specially qualified to be of use, and then to accept no fee. This may sound a hard condition, and it would be so if externally imposed, but so powerful is the attraction of scientific work that we understand this is a self-imposed condition in the case of some ex-

isting professors. We think the conditions of a professor's employment are a matter which must be left to the university to determine; but in our opinion it is not necessary or advisable to prohibit private practise altogether.

Thus the duties of the clinical teachers in a medical school are defined. They certainly do correspond well with the opinions of some of our leading educators. Enough has been said to show the trend of the report, the full meaning of which can not be had without studying all of the pages of this excellent document. At any rate it is clear that there are far-sighted reformers on both sides of the Atlantic.

Whether or not a great hospital should conduct pay wards is not discussed. However, it is stated that in a hospital which has no end in view but medical education and the advancement of medical science, the public interest must be considered, and the question of the privilege of access to the great London hospitals can not be treated as a matter of private right or decided as if it were the private property of the existing medical schools.

FRANKLIN P. MALL

THE OPTICAL ACTIVITY OF PETROLEUM AND ITS SIGNIFICANCE[1]

THE wide distribution of deposits of bitumen, in its various forms, is attested in the very earliest writings, both sacred and profane. In the book of Genesis we learn that slime was used for mortar, and in the second book of the Maccabees we are told that

> Neemias commanded the priests to sprinkle the sacrifices with the thick water . . . and when this was done . . . there was a great fire kindled, so that every man marvelled.

Herodotus gives us the following description of the manner of its collection:

> At Ardericca is a well which produces three different substances, for asphalt, salt and oil are drawn up from it in the following manner: It is pumped up by means of a swipe, and, instead of a bucket, half a wine skin is attached to it. Having dipped down with this, a man draws it up, and then pours the contents into a reservoir, and, being poured from this into another, it assumes these different forms: the asphalt and the salt immediately become solid, but the oil they collect, and the Persians call it rhadinance. It is black and emits a strong odor.[2]

For more than 2,500 years the disciples of Zoroaster have worshiped the "eternal fires" in the neighborhood of Baku, Russia, and not until recently have their temples been replaced by oil reservoirs and refineries.

Within the last half century a new shrine has been set up in oildom, and our modern devotees have shown such zeal and activity that it may again well be said "that every man marveled." But the marvelous development of the petroleum industry has been rendered possible only by reason of the gigantic strides which have been made in the fields of natural science and technology. We may look for even greater things in the future, for science is still in its infancy. I have chosen for my subject to-night what I consider to be one of the infant industries of science.

In the year 1835 Jean Baptiste Biot published his memoir on the circular polarization of light and its application to organic chemistry,[3] which contains a table giving polarimetric data regarding essential oils. This includes a sample of "naphte" rectified by distillation, which, examined by red light gave a rotation to the left equivalent

[1] Address of the retiring president of the Kansas Academy of Science. Read December 23, 1912, at Topeka, Kansas.

[2] "Petroleum and its Products," S. F. Peckham, 1882, p. 1.

[3] *Mem. de l'Acad. de Sciences*, 13: 39, 1835. See also "Die Polarimetrie der Erdöle," M. A. Rakusin, Berlin, Wien, p. 6, 1910.

to 15.21° for a tube length of 200 mm. It is, however, very unfortunate that we have no information as to the source of this very remarkable sample.

Nearly fifty years later, in connection with their researches upon the petroleum of the Caucasus,[4] Markownikow and Ogloblin examined the natural "white naphtha" as well as some petroleum distillates, and, finding these samples inactive, they did not continue this subject any farther. In 1885, however, Demski and Morawski[5] examined some of the more important mineral oils of commerce, among which one rotated the plane of polarization 1.2° to the right. In 1898, Soltsien[6] found that the commercial paraffin oils are dextrorotatory, and that the amount of rotation increases with their specific gravity. Since that time general interest has been awakened in this subject and petroleums from all parts of the world have been examined polarimetrically. In general, it has been found that the lightest and least colored oils (including the so-called white naphthas) manifest little or no optical activity, while the heavier, dark and viscous oils yield active products.[7]

In a typical Kansas oil, examined in connection with the work of the University Geological Survey, slight optical activity was detected in the upper kerosene fraction which distilled between 250° and 300° under ordinary atmospheric pressure. The higher boiling portions of this oil after fractional distillation under diminished pressure were dextrorotatory, the amount of rotation gradually increasing with the rise in boiling point until, in the neighborhood of 280° at 27 mm., it reached almost one degree of arc.[8]

In some oils a maximum activity has been observed in the vacuum distillates collected at about 275°, and in the case of a German oil a second maximum was reached at a temperature of 310°. Javanese petroleum yields vacuum fractions boiling about 150–180° which are lævorotatory, but the higher boiling fractions are dextrorotatory.[9] A sample of petroleum from Borneo yielded a distillate collected between 260° and 340° under atmospheric pressure which was lævorotatory.[10] A lævorotatory activity has also been reported in an oil from Argentine Republic.[11]

But the fractions obtained in the distillation of petroleum do not represent distinct chemical individuals, but consist of more or less complex mixtures. Hence it is necessary for us to make use of other processes before we can isolate the optically active constituents. The fact that the distillation products of petroleum have found such a ready market without the necessity of chemically transforming them has, no doubt, greatly hindered the development of chemical methods for their utilization. But in recent years competition in the refining of illuminating oils is beginning to force the refiners to look to the utilization of their waste products. In Russian refineries the alkaline sludges are now treated so as to recover the so-called naphthenic acids which find a ready market for the manufacture of cheap soaps.

The fact that the naphthenic acids derived from kerosene show greater optical

[4] *Annales de chim. et de phys.* (6), t. II., 387, 1884.

[5] *Dingler's Polytech. Jr.*, 258: 82, 1885.

[6] *Chemisches Centralblatt*, I., 869; II., 455, 1898.

[7] Zaloziecki and Klarfeld, *Chemiker Zeitung*, 1170, 1907.

[8] Univer. Geol. Survey of Kansas, Vol. IX., p. 317, 1908.

[9] "Die neueren Ansichten über die Entstehung des Erdöls," C. Engler, Berlin, p. 55, 1907.

[10] Jones and Wootton, *Jr. Chem. Soc.*, 91: 1146, 1907.

[11] Longobardi, "Petroleum," VI., 552, 1911. *Jr. Russ. Phys.-Chem. Soc.*, 43: 792, 1911.

rotation than the kerosene was first observed by Rakusin.[12] The naphthenic acids derived from lubricating oils were found by Marcusson[13] to be much more strongly active than those derived from kerosene.

A study of isomeric naphthenic acids[14] has recently been made in the laboratory of industrial research of the University of Kansas. Commercial naphthenic acids, after being freed from hydrocarbons, were converted into esters, which were repeatedly fractionally distilled. The lowest boiling fractions were strongly lævorotatory. The succeeding fractions showed a gradual decrease until in the intermediate fractions a neutral or inactive point was reached. Above this there was a gradual increase in dextrorotatory activity. A portion of free naphthenic acids, which were similarly purified, were separately fractionated and gave results exactly parallel to those of their esters, the only difference being that the boiling points of the free acids were uniformly about 50° higher than the boiling points of their methyl esters. In other words each and every optically active constituent boiled 50° higher in the one case than in the other. This shows that these optically active constituents are acids which are esterifiable, and marks the first distinct step toward their isolation. The simplest interpretation of these facts is that the cause of the optical activity resides within the naphthenic acids themselves.

It does not necessarily follow, however, that the optically active constituents present in the commercial naphthenic acids are identical with those originally present in the petroleum. There seems to be good evidence that this is not the case, for it has been shown by Albrecht[15] that the optical activity of lubricating oils is not appreciably reduced by thorough refining by means of alkali. This result has also been confirmed by experiments with the Kansas oil distillates already mentioned, which retained most of their optical activity after being boiled with alcoholic potash. On the other hand, these experiments do not prove that no optically active acids are removed by the treatment with alkali, for it is quite possible that both lævorotatory and dextrorotatory acids may be removed in approximately equal quantities. To satisfactorily settle this question an experiment should be carried out at a refinery upon a large quantity of oil.

The naphthenic acids are generally believed to be the oxidation products of the naphthenes, or saturated cyclic hydrocarbons of the series C_nH_{2n}, which are present in most of the petroleums, but particularly in those of Russia. It is to be expected, therefore, that active acids should result from the oxidation of certain active hydrocarbons. The determination of the constitution of any of the active acids to be found in petroleum products would thus shed light upon the constitution of the active hydrocarbons from which they were formed.

The crucial test as to the correctness of our knowledge of the constitution and structure of organic compounds depends upon the methods for their synthesis. But chemical synthesis is a species of architecture, and just as the architect before beginning the erection of his structure must

[12] "Die Untersuchung des Erdöls und seiner Produkte," p. 178, 1906.

[13] *Chemiker-Zeitung*, No. 33, p. 421, 1907.

[14] Orig. Com. Eighth Internat. Cong. Appl. Chem., VI., 57–67, 1912. The same isomeric naphthenic acids have since been independently isolated, by the method of repeated fractional crystallization of their amides, by Gadaskin and Zaverschinsky, *Jr. Russ. Phys.-Chem. Soc.*, 45: 377, 1913.

[15] *Chemische Revue*, 18: 189, 1911. See also "Die Polarimetrie der Erdöle," M. A. Rakusin, p. 39.

lay down his plans and draw his designs so that each and every part shall be fitly adapted to its specific use, so the chemist must first in his imagination plan the order and arrangement of the various elements and groupings which are to be combined in such a manner as to produce the desired specific results.

The distinguishing characteristic in the structure of the optically active organic substances is that they contain at least one carbon atom which is combined with four different atoms or groups. If we consider the space distribution of the four different atoms or groups about the central carbon atom, we shall find that two arrangements are possible. The two resulting forms are related to each other in the same manner as an asymmetric object and its mirror image. Such a carbon atom is called an asymmetric carbon atom. We have for each substance containing such an asymmetric carbon atom the possibility of a right-handed structure and a left-handed structure. Corresponding to these theoretical structures we find that nature has furnished us with dextrorotatory and lævorotatory isomeric substances, which are closely identical in all of their physical and chemical properties, but differing chiefly in that the one rotates the plane of polarized light as far to the right as the other does to the left. When these two so-called stereoisomeric substances are mixed in equal quantities the resulting product is inactive. So also, when two asymmetric carbon atoms occur within the same molecule inactivity may result from internal compensation. It is thus found that among substances of asymmetric structure there are two classes which are optically inactive. The members of the one class—said to be inactive by internal compensation—are not separable into active components, while the members of the other class—said to be inactive by external compensation—are separable into dextrorotatory and lævorotatory components.

We have three methods for the separation of the optically active components, all of which are due to the researches of Pasteur.[16]

1. In some instances enantiomorphic crystals may be formed which may be mechanically separated.

2. By the aid of suitable active substances compounds may be formed which differ in their solubility, thus permitting the two optical isomers to be separated by fractional crystallization.

3. Through the action of certain microorganisms one of the optical isomers may be destroyed by fermentation while the other remains unaffected.

The direct synthesis of optically active substances from inactive material has not been effected, because both of the stereoisomeric forms are simultaneously produced by synthetic processes, but the same result is accomplished indirectly by first synthesizing the inactive mixture, or compound, and then separating the components by one of the methods already mentioned.

When, however, we find in nature substances which show optical activity we know that they must contain constituents which are asymmetric in structure. In endeavoring to determine their constitution, the chemist, therefore, gains the distinct advantage of leaving out of consideration all that vast array of substances which are symmetrically built, and of being permitted to concentrate his attention and efforts upon the relatively few possibilities of asymmetric structure.

But the chemist is not alone in the ad-

[16] "Researches on the Molecular Asymmetry of Natural Organic Products," by Louis Pasteur (1860), Alembic Club Reprint No. 14.

vantage thus gained. From what has been said regarding synthesis from inactive material it follows that all theories accounting for the formation of petroleum from inorganic material, and excluding the action of optically active organic substances, must be rejected.

But still another factor which must be considered by the geologist with reference to the origin of petroleum and other optically active bitumens is that of temperature. All theories involving violently energetic chemical reactions and the production of high temperatures must likewise be rejected.

Having thus limited the possibilities of petroleum formation, it is well to inquire what sources remain which are capable, under the conditions imposed, of supplying a sufficient amount of material for the accumulation of the vast stores which are being unearthed, and also whether the study of the polarimetric data gives promise of furnishing positive specific evidence as to the kind of material from which petroleum has been derived.

In answer to the first of these questions I quote from the report of Professor Haworth.[17]

> Few people realize the vast amount of organic matter annually carried down to the ocean by surface drainage. Vegetation covers practically the entire dry land area of the earth and has done so throughout all geologic time. Varying climatic conditions and other influences doubtless have made a corresponding variation in the richness of organic materials in different rock masses. But when all allowances are made for such variations, it remains that the amount of organic matter thus entombed is and has been enormously great. And such matter need not be confined to vegetation, for our ocean-water is teeming with animal life. Speaking broadly, it is well known that animals subsist on vegetation, and that the constant addition of food matter to the ocean-water for the ocean fauna comes from vegetation, as plants are the great agents for changing inorganic matter into organic matter. . . . If one will put himself into a position which makes it necessary to give a reasonable account for the whereabouts of all this vast quantity of organic matter, animal and vegetable, which has been engulfed in the masses of stratified rock, one will find that the quantity of oil and gas now available is all too small, rather than too large, for such accounting.

[17] The University Geological Survey of Kansas, Vol. IX., 194–195.

Even though the study of the chemical constituents of petroleum is in its infancy, attempts have already been made to detect among them specific optically active substances which may definitely and with certainty reveal their origin. The substance which has received the greatest consideration from this standpoint is cholesterin, the optically active constituent of many animal fats, or phytosterin, its vegetable equivalent. Cholesterin when distilled yields products which closely resemble the distillation products of petroleum. Furthermore, the optically active petroleum distillates usually give the same color reactions as are given by cholesterin products. Chemists are inclined, however, to view color reactions with suspicion, and demand more positive methods of proof of identity than the supporters of the cholesterin hypothesis have been able to furnish. On the other hand, the amino-acids and numerous other decomposition products of albuminous material as well as the remains of balsams, resins, terpenes, tannins, etc., must all be looked upon as contributing to the optical activity of the organic remains which may retain them. The time is ripe for the study and solution of problems of this nature.

The knowledge of the nature of the substances contained in petroleum which is to be revealed through the instrumentality of their optical properties may be put to practical use in the development of methods for extracting them and utilizing them for industrial purposes. The output of petro-

leum refineries in the past, even though enormous in quantity, has been restricted almost entirely to the extraction and clarification of products which exist ready-made in the crude oil. The various grades of gasoline and naphtha, illuminating oil, lubricating oil, paraffin, fuel oil and road oil are all marketed in a low-developed stage in the art of manufacture. The coal-tar industry, on the other hand, which utilizes a crude material closely resembling petroleum, and not a bit more inviting, has reached a high stage of development in that its products are completely transformed into an almost infinite variety of costly dye-stuffs, flavoring matters, medicinal preparations and other articles which have contributed to our wealth, our comfort and to the advance of our civilization. This utilization of what was formerly a waste product which could be disposed of only at considerable expense is a splendid example of what chemical industrial research has accomplished. The fact that petroleum products are not similarly utilized simply demonstrates that we lack the requisite knowledge.

F. W. Bushong

AN ASCENT OF THE SNOW MOUNTAINS OF NEW GUINEA

Dr. A. F. R. Wollaston has recently returned from his second expedition to Netherlands, New Guinea. Last year he published an official account of the unlucky expedition of the British Ornithological Union to the "Snow Mountains" of New Guinea. Those who have read his "Pygmies and Papuans" (London, Smith, Elder & Co., 1912) will gain some idea of the extreme difficulty of traveling in the unknown districts of that island. That expedition did not attain its main objects, but, determined not to be beaten, Dr. Wollaston has made another attempt, which has proved successful. On the present occasion Mr. C. B. Kloss, curator of the Kuala Lumpur Museum, Federated Malay States, accompanied Dr. Wollaston, and, in addition to an engineer and five native collectors, they took with them seventy-five Dyaks, and a large escort was provided by the Netherlands government. It took four and a half months to reach the mountains from the coast. The mountains, as approached from the south, are a steep escarpment of limestone rock rising abruptly from broken foothills, through which many large torrents flow in excessively steep gorges. The heavy forest of the low country extends up to between 6,000 and 7,000 feet, beyond which height it becomes less dense, and more herbaceous plants appear. Geraniums, gentians, daisies and many other palæarctic forms, besides numerous terrestrial orchids, are found in the higher regions. The limit of perpetual snow on the Ingkipulu Mountains (Nassau range) was found to be at a height of about 14,200 feet.

Unlike the Mimika River, visited by the former expedition, the Utakwa is uninhabited, probably on account of the absence of sago. The expedition was frequently visited by natives from other rivers, some of whom came from great distances. Unfortunately, they did not provide themselves with supplies for the return journey, and as the expedition proceeded on its way it encountered the dead bodies of some 30 or 40 natives, mostly women and children, whose curiosity had led them down to the low country, and who had perished from exhaustion as they were going home. The meeting with these bodies was the most terrible experience of the expedition. A hitherto unknown tribe of a rather short people of Papuan type were met with at an elevation of some 4,000–6,000 feet. Despite the very cold nights they wear no clothing. They are mainly collectors and hunters, but also grow sweet-potatoes, tobacco and sugar cane. They carry bows and arrows and shoulder bags containing apparatus for making fire, tobacco, knives, spoons and other small belongings in true Papuan style. Their knives are made of a hard, slaty stone that can be brought to so keen an edge that bamboos can be cut with them. The people are said to be extremely attractive, most friendly and in some respects

more intelligent than the people on the coast. Considerable ethnological collections were made, a few skulls of the mountain people were obtained and numerous photographs taken.

The extensive zoological collections comprise some 1,300 birds, 150 mammals, a large number of snakes and other reptiles, and several thousand insects. Among the birds is a very beautiful bird-of-paradise, which may prove to be new to science.

A. C. HADDON

SCIENTIFIC NOTES AND NEWS

DR. JOHN H. FINLEY, president of the College of the City of New York, was appointed State Commissioner of Education by the State Board of Regents on July 2. Dr. Finley succeeds the late Dr. Andrew S. Draper.

NORTHWESTERN UNIVERSITY has conferred the degree of doctor of science on Dr. Robert Andrews Millikan, professor of physics in the University of Chicago.

PROFESSOR ALEXANDER GRAHAM BELL has received the honorary degree of doctor of laws from Dartmouth College in recognition of his invention of the telephone.

THE University of Michigan has conferred the honorary degree of doctor of science on Dr. Otto Klotz, astronomer of Ottawa, Canada.

THE Royal Agricultural Society of England has awarded its honorary diploma of membership to James Wilson, lately U. S. Secretary of Agriculture.

ON June 4 a number of former pupils of Professor W. E. Byerly, Perkins professor of mathematics, emeritus, at Harvard University, gave an informal dinner in his honor at the Union Club, Boston. Professor E. H. Hall was toastmaster, and the speakers were Professor Byerly, President Lowell, President Eliot, Professor Bôcher and Professor E. B. Wilson, of the Massachusetts Institute of Technology. At the close of the dinner Professor Byerly was presented with a gold watch as a gift from over 250 of his former pupils.

WE learn from *The Electrical World* that at the annual meeting of the Verein Deutsche Ingenieure, held at Leipzig, Germany, on June 23, and attended by the visiting members of the American Society of Mechanical Engineers, the Grashoff gold medal was awarded to Mr. George Westinghouse. The medal was established by the Verein in 1894 in honor of one of its founders, Frank Grashoff, who died in 1893. Each year the memorial is presented to an engineer who has rendered distinguished service to technology. Mr. Westinghouse is the first American to receive the medal. Others to whom it has been awarded are Sir Charles A. Parsons, England; Mr. Gustav de Laval, Sweden; Count Ferdinand von Zeppelin, Germany, and Mr. Aurel Stodola.

DR. C.-E. A. WINSLOW has been appointed chairman of a commission on the experimental study of ventilation problems, with an appropriation of $50,000 to be expended during the next four years. The other members of the commission are: Professor F. S. Lee, of the College of Physicians and Surgeons, Columbia University; Professor E. L. Thorndike, Teachers College, Columbia University; Professor E. B. Phelps, Massachusetts Institute of Technology; Dr. James Alexander Miller and Mr. D. D. Kimball. The fund is part of a gift made by Mrs. Elizabeth Milbank Anderson to the Association for Improving the Condition of the Poor.

M. DEBOVE, professor of clinical medicine in the University of Paris, has been elected permanent secretary of the Académie de Médicine, in the place of the late Professor Jaccoud.

DR. IRA D. CARDIFF, professor of botany in the State College of Washington, has been appointed director of the Washington Experiment Station.

DR. J. A. ALLEN, of the American Museum of Natural History, has been working at the British Museum during the past six weeks on the mammals of Korea and South America. His work is particularly complete on South American squirrels, the material which Mr. Chapman's expedition secured in Colombia and the large unidentified collections of the

British Museum providing for an entire revision of the group. The work on the Korean mammals collected by Mr. Andrews in northern Korea had the benefit of comparison with British Museum specimens secured by the Duke of Bedford's earlier expedition to Korea, the British Museum being practically the only institution in the world which contains any series of mammals from the region.

Mr. Guy West Wilson has been appointed special agent by the U. S. Bureau of Plant Industry for the study of the relation of the chestnut blight fungus to tannin and other plant products. He will be stationed at Rutgers College, New Brunswick, N. J., and work with Professor Mel. T. Cook, of that institution. He began work on July 1.

Professor A. G. Tansley, of Cambridge University, England, editor of the *New Phytologist,* will spend the greater part of the summer in America visiting botanical centers and participating in the phytogeographical excursion which is planned for the summer.

Dr. P. E. Goddard, of the American Museum of Natural History, is preparing for a trip to the upper Peace River country of northwestern Canada to make a study of the Beaver Indians, a little known tribe of the northwest; and Dr. Herbert J. Spinden will spend the summer in New Mexico on ethnological work among the Pueblo Indians of the Rio Grande Valley.

Mr. F. G. Clapp, managing geologist of the Associated Geological Engineers, sailed for Europe on June 24, for professional work in Hungary.

The Princeton University department of geology is sending a party consisting of Professor Gilbert van Ingen, in charge, Messrs. Nelson C. Dale and A. F. Buddington, fellows, and Mr. B. F. Howell, Jr., assistant in geology, to Newfoundland, to study the geology of the Conception and Trinity Bays regions. Certain problems of Cambro-Ordovician stratigraphy developed by Professor van Ingen and Mr. A. O. Hayes during their Newfoundland work in 1912, the pre-Cambrian pyroclastic and unaltered sedimentary clastic rock, and a highly interesting interbedded manganese deposit are the special problems to be studied.

The Charles Finney Cox collection of Darwiniana has been installed in a case built for it and placed in the library reading room of the New York Botanical Garden. The privilege of consulting it has already been granted to several students, and its value as a practically complete collection of the published writings of Charles Darwin will constantly increase. A bronze statuette of Charles Darwin is placed on top of the case.

Sir Archibald Geikie writes to the London *Times,* under date June 12, as follows:

Another of the vanishing literary landmarks of London is marked out for destruction. On the east side of St. Martin's-street, immediately to the south of Leicester-square, there still stands the house in which Isaac Newton spent the last 17 years of his life, and which he made the center of scientific life in this country. There he wrote and worked in the little observatory which he constructed at the top of the house. In later years the building was tenanted by Dr. Burney, author of the "History of Music," and there, unknown to him, and betaking herself to Newton's quiet garret studio, his daughter Fanny wrote her "Evelina." The house thus became as famous for its literary associations as it had been for its connection with the leaders of science. The whole property, including this house and Orange-street Chapel, belong to a trust, which is offering it for sale at the price of £30,000 for the freehold or on a building lease for 80 years at a yearly rent of £825. Newton's house occupies about a third of the site. I assume that to obtain an adequate return for the outlay of such sums would involve the demolition of the present buildings to make way for modern warehouses, offices or shops. I fear that no society or association, whether literary or scientific, nor any combination of such institutions could raise money enough to save Newton's house from destruction. But I have thought it desirable to call public attention to the matter in the faint hope that means may yet be devised to preserve so interesting a memorial of the past intellectual life of London.

We learn from *Nature* that on June 5 the faculty of science of the University of Geneva erected a bust to the memory of Pierre Prevost (1751–1839), the Geneva man of science

whose name is remembered by Prevost's theory of exchanges. Professor C. E. Guye presided at the ceremony, and most of the learned societies with which Prevost was associated sent delegates, or addresses of congratulation. M. G. Lippmann represented the Paris Academy of Sciences, and delivered an oration. The Royal Society and the Royal Society of Edinburgh were represented by Dr. W. H. Young, F.R.S., and Mr. Mitchell, respectively, who presented addresses in English. The Berlin Royal Academy of Sciences sent a letter of congratulation signed by Professor Planck.

CHARLES GREEN ROCKWOOD, professor emeritus of mathematics at Princeton University since 1905, died on July 2 at Caldwell, N. J., aged seventy-one years.

AT a meeting of the Royal Astronomical Society in London on June 13, Professor E. C. Pickering described the work being accomplished at Harvard College Observatory; Professor H. N. Russell, of Princeton University, spoke of his work in correlating the actual intrinsic brightness of the stars with their spectra, and Mr. S. S. Hough, astronomer at the Cape of Good Hope, gave details of the work being done at the Cape Observatory.

THE twentieth summer meeting and seventh colloquium of the American Mathematical Society will be held at the University of Wisconsin, Madison, Wis., during the week beginning Monday, September 8, 1913. The first two days will be devoted to the regular sessions for the presentation of papers. The colloquium will open on Wednesday morning and will close Saturday morning. Courses of lectures will be given by Professor L. E. Dickson, of the University of Chicago, on "Certain aspects of a general theory of invariants, with special consideration of modular invariants and modular geometry"; and by Professor W. F. Osgood, of Harvard University, on "Topics in the Theory of Analytic Functions of Several Complex Variables."

ARTHUR JAMES, London, has given the income of $100,000 to the Middlesex Hospital, London, in memory of his brother, William James, for the investigation of the causes of, and the search for a cure for, cancer.

NOTICE of the contest of the will of the late Henry E. Rutherford, who left a legacy of $200,000 to the Rockefeller Institute for research in cancer, has been filed.

UNIVERSITY AND EDUCATIONAL NEWS

MR. ANDREW CARNEGIE has contributed $20,000 toward the installation of the Institute of Chemistry of the University of Paris.

THE London *Times* states that in accordance with the policy of circumscribing the vast areas of affiliation of colleges to existing Indian Universities, definite steps are being taken to establish a university at or near Patna for the recently created Province of Behar and Orissa. The Lieutenant-governor in Council has appointed a committee, with Mr. R. Nathan, I.C.S., as president, to frame a scheme for the purpose. As in the case of the similar scheme for a university at Dacca for the eastern portions of Bengal and for Assam, the report will be published and circulated for opinion before action is taken on the recommendations.

DR. REID HUNT, chief of the division of pharmacology, U. S. Public Marine Service since 1904, has accepted the position of professor of pharmacology at Harvard Medical School to succeed Dr. Pfaff.

DR. J. B. WHITEHEAD, formerly professor of applied electricity in Johns Hopkins University and fellow of the American Institute of Electrical Engineers, has been appointed head of the department of electrical engineering in the new School of Technology of the university.

DR. WILFRED HAMILTON MANWARING, formerly assistant in pathology and bacteriology in the Rockefeller Institute, has been appointed professor of bacteriology and immunity at Leland Stanford Junior University, San Francisco, Cal.

THE following changes have been made in the department of chemistry at Miami University: Raymond M. Hughes, professor of chem-

istry since 1898, and acting-president since 1911, has been elected president of the university. William H. Whitcomb has been advanced from associate professor to professor and head of the department. James E. Egan, Ph.D. (Illinois, 1912), has been elected assistant professor to fill the vacancy caused by the resignation of Harvey C. Brill, Ph.D. (Michigan, 1911), to enter the government service in the Philippine Islands.

Dr. Geo. T. Hargitt, instructor in zoology at Northwestern University, has been appointed assistant professor of zoology at Syracuse University to fill the position made vacant by the transfer of Dr. Blackman to the School of Forestry.

Mr. Maurice Picard, M.A. (Columbia, '11), has been elected assistant professor of botany in Middlebury College.

At the University of Wyoming Mr. C. J. Oviatt, of the Michigan Agricultural College, becomes extension professor of agriculture and state leader in farm management and demonstration; Mr. A. E. Bowman, of the Utah Agricultural College, becomes extension professor of agriculture and assistant state leader in farm management and demonstration; research chemist, S. K. Loy, becomes professor of chemistry and research chemist; engineering chemist, Karl Steik, becomes assistant professor of chemistry and engineering chemist.

Mr. H. Clay Lint, of the Kansas Agricultural College, has accepted the industrial fellowship in plant pathology recently established in Rutgers College. He will begin work on July 15.

The General Board of Studies of Cambridge University have made the following appointments: Dr. Baker to be Cayley lecturer, and Dr. F. H. A. Marshall to be university lecturer on animal physiology, each for five years; and Mr. F. J. M. Stratton, M.A., Caius, to be university lecturer in astrophysics until March 31, 1918.

Professor Emil Abderhalden, professor of physiology in the University of Berlin, has declined the call to Vienna as the successor of Professor Ludwig.

DISCUSSION AND CORRESPONDENCE

THE COMPLEXITY OF THE MICROORGANIC POPULATION OF THE SOIL

Mr. E. J. Russell, of Rothamsted Experiment Station, has contributed a very interesting article in Science, under date of April 4, 1913.

In his opening sentence Mr. Russell says:

> During the last few years a series of experiments have been carried out in this laboratory by Dr. Hutchinson and myself which we can only interpret as showing that bacteria are not the only active inhabitants of the soil.

I write to say that I agree with this conclusion. I also agree fully with most of his statements of fact in paragraphs 1, 2, 3, 4, 5, and 6, and also with his paragraphs 7, 8, 9 and 10—in so far as they apply to the results obtained, though of course I can see no necessity of assuming that the protozoa constitute the "limiting factor" which is extinguished through partial sterilization. Mr. Russell is possibly right when he says:

> It is evident that the factor limiting bacterial numbers in ordinary soils is not bacterial, nor is it any product of bacterial activity, nor does it arise spontaneously in soils.

Though from their experiments, I see no necessity of assuming that the protozoa bring about this limitation.

In my article entitled "Interpretations of Results Noted In Experiments Upon Cereal Cropping Methods After Soil Sterilization," in Science, under date of February 10, 1912, I called attention to the thought that it might clarify matters to see what would happen in the case of "actual sterilization" of the soil.

I now call attention to the fact that in the Russell-Hutchinson experiments the sort of sterilization mentioned as being "partial" is just as liable to be effective against a large number of saprophytic fungi as it is to be effective against encysted amœboid types and that such saprophytic or semi-saprophytic fungus organisms are known to be as great reducers of organic matter, at least in its preparatory stages for bacterial activity, as some of the bacteria themselves.

If Messrs. Hutchinson and Russell are only

interested in finding out what limits the activity of the bacteria in the soil, then they and I are working upon two different problems. It would appear, however, that they wish to find out what it is that limits the bacterial activity in order that they can say that when this bacterial activity is limited there is a lessened ammonification, so that they may make the further assumption that when there is lessened ammonification there is of necessity a lessened yield of grain on the soil. In other words, they would account for the lessened or deteriorated grain product on such soils. In their regular reports in the *Journal of Agricultural Science*, they have actually made such thought transfers.

We have gone at the problem more directly in our experiments with the purpose in view of ascertaining what it is that tends to limit the grain production or to bring about deteriorated grain on fertile soils, and in doing so we have found that if we bring about rather perfect sterilization in potted soils, the limiting factor on grain production is done away with, provided we do not reintroduce it by means of internally infected seeds or other wheat disease-producing matters. Bacteria and amœbæ do not seem to play any primary part in this problem of deteriorated cereal crops.

The chemists have so thoroughly filled our minds with their belief that improvement in grain production or deterioration in grain production can only be accounted for because of modified elements of plant food that it would seem that some bacteriologists are coloring much of their work with an attempt to prove that bacteria are necessary to bring about those modifications which the chemists assume to take place.

The peculiar thing which our experiments make plain is that when we have a purified seedling placed in a purified soil, they show no element of weakness or tendency to deteriorate. Furthermore, our experiments do not show any particular necessary relationship associated with ammonification and such plant production. Deterioration takes place regardless of the presence or absence of high ammonification. We find, in ordinary soils, that a rather poor soil can produce perfect wheat seeds if free from parasitic organisms. We find also that a rich soil can not produce perfect wheat, regardless of its fertility and the amount of ammonification, if certain organisms are present in the soil or the seed.

Finally, I agree with Messrs. Russell and Hutchinson that microorganic population of the soil is "very complex," and would call their attention to the fact that in order to produce wheat on certain kinds of soil they will have to find types of amœba or other microorganism which will be capable of eating some very large fungi endways. Though we have checked up much of the work on soil toxines and gone into the bacterial proposition very carefully, especially with regard to ammonification, I yet must say that I am unable to find any cereal crop-limiting factors of any importance associated either with indefinite toxic substances or with the activity of bacteria. Having a given amount of available fertility, the plants get along. We have, however, found that there are at least one or more species each of the following mold-like fungi which, when in the soil, are real cereal crop-limiting factors: *Fusarium, Alternaria, Helminthosporium, Colletotrichum, Macrosporium* and *Ophiobolus*.

We find that most of these organisms are not only persistent in the soil, remaining there by way of the stubble and roots of their host plants, but may be introduced with the seed, fresh or improperly composted manures, etc., most of them being what may be spoken of as internal seed-infecting organisms. I would again call attention to what to me is an evident fact: that those who are working on the bacterial and toxine phases of the question of soil fertility will never have any results which they are justified in making use of until they are able to plant disease-free seedlings either in the soil or in their special cultures and to eliminate the disease factor in the soil. We have, of course, conducted many experiments, or I would not feel justified in making so strong statements as these. Were the problem of the soil fungi in wheat chopping less complex, I should long since have been giving out

much of the detail of the work at this experiment station. I will here, however, make one very interesting statement, based upon experimental results: In 1911 we had made many plantings of what we call "agar purified wheat seedlings" placing these in soil which we found to be free from the sort of organisms which we find to inhabit the average seed grain of wheat. It is not an easy matter to get an agar purified seedling—one which will grow in an agar made of synthetic media to represent the soil, or whose food basis consists of soil solution, in such manner that neither bacteria, fungi, or other organisms are found to be present in association with the roots.

When we were finally able to produce such agar-purified seedlings, they have been transplanted. In one set of such plantings in 200 lots, the average crop of wheat from such purified seedlings was 11.07 heads per seed produced on an average of 17.24 stools per seed. The heads thus grown were of rather perfect form and gave an average of 21.8 grams of nice plump wheat per plant while an untreated seedling of the same pure-bred strain of wheat, selected to the same perfect form and planted on the same day on the same soil gave an average of 6.11 heads on 8.5 stools and an average of 4.7 grams of seed.

It would make this piece of correspondence too extended to give other data of other types of seedling purification, seed treatment and soil treatment. These will not be given until published in tabular form in our regular station bulletins, but I may say that we have found that in a soil which has sufficient fertility to produce a crop, bacteria do not appear to be particularly needed so far as that individual crop is concerned, while there are certain parasitic and semi-parasitic mold-lime organisms which love the soil and the seed which are particularly detrimental and represent the chief crop-limiting factor aside from mineral elements and atmosphere.

There was a time when the bacteriologists thought they could tell safe or potable water by making counts of the number of organisms present. So now, there seem to be quite a few who think they can tell a productive soil by the number of organisms that are present therein, or by the amount of ammonification that may be or may not be taking place therein. It does not seem to be true with regard to either potatoes, flax or wheat. It made a material difference what kind of organisms were in the drinking water, so also it makes a material difference what kind of microorganisms are in the soil, and I have been unable to find that the amœbæ or their allies are particularly harmful or beneficial as associated with wheat cropping. There may, however, be some destructive fellows among them.

In making these statements, I would, of course, not be misinterpreted as assuming that bacteria do not have a useful place in the formation of plant food in the soil, nor would assume that, to a certain extent, amœboid organisms may not in part affect this development, but after a very careful reading of "Investigations on Sickness" in soil by Russell and Golding in *Journal of Agricultural Science*, Vol. V., Part 1, and the report of Messrs. Russell and Hutchinson on "The Effect of Partial Sterilization of Soil on the Production of Plant Food," as well as their original article on the same subject, October, 1909, in *Journal of Agricultural Science*, Vol. V., Part 2, I am unable to see that their experiments in any way prove a relation between amœboid activity and bacterial inactivity, nor can I see that there is any justification in the assumption that their studies in sewage-sickness show any feature characteristic of cereal sickness in arable soils. A sewage-logged soil is, at best, a poor analog of a cereal-sick arable soil. While no one can doubt that bacteria are the chief active agents in the preparation of plant foods from the rough organic remains of ordinary cropping refuse, that is one problem, and crop deterioration, as such, is another, which is superimposed upon the primary conditions of soil fertility. The crop deterioration problem is probably a problem of crop sanitation as involved in infectious disease.

H. L. Bolley
North Dakota Agricultural College,
May 15, 1913

FOWLERINA EIGENMANN A PREOCCUPIED GENERIC NAME

IN the *American Naturalist* for 1907, p. 767, Dr. Carl H. Eigenmann proposes very magnanimously the generic name *Fowlerina* for a genus of stethaprionine characins. He gives *Tetragonopterus compressus* Günther as the type.

The name, however, is antedated by *Fowlerina* Pelseneer, *Trans. Linn. Soc. London* (2), X., February, 1906, p. 149, proposed as a new genus of mollusks.

I therefore propose the generic name EPHIPPICHARAX, and give *Tetragonopterus compressus* Günther also as the type. Apparently, two species are known from the Amazons, Guiana, Paraguay and eastern Brazil. The genus is remarkable for the peculiar scale-like predorsal spine, which fits into a depression in the back. It is closely allied with *Stethaprion* Cope.

HENRY W. FOWLER

ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA,
June 12, 1913

SOME ADDITIONAL NOTES ON THE BLOWING OF SOILS

IN SCIENCE, Vol. XXVIII., pp. 653–654, I published an article on the "Blowing of Soils." I wish to add these further notes on the same subject.

It has snowed here (Nett Lake, Minn.) for practically one continuous week now and more than eighteen inches of snow has fallen in that time. The snow on the ground now is three and one half feet deep. Even the ice in the lakes is so pressed down by the additional weight of snow that the water rising on it on account thereof has stopped all lake transportation and travel. But to the subject. Yesterday with a nearly west wind, bearing a little to the north, with a velocity of probably eight miles per hour, the continuous snow that fell was so filled with dirt that it was brown. It was so conspicuous that even the Indians called my attention to the dirty snow. This dirt in the snow here was the product of a dust storm somewhere. With the snow three and one half feet deep here it must have come from the country about Medicine Hat in Canada or from the northern part of the Dakotas. From conditions here it must at least have come five hundred miles.

ALBERT B. REAGAN

NETT LAKE, MINN.,
March 20, 1913

MOSQUITOES POLLINATING ORCHIDS

IN August, 1899, seven mosquitoes bearing pollinia of the tall green orchid, *Habenaria hyperborea,* were taken at a camp on the Medicine Bow Range in northern Colorado, at an altitude of 10,200 feet. Four individuals carried two pollinia each; three carried one each. The viscid disks were attached to the lower front of the head and in some cases partially covered the eyes.

The captures were made on a rainy day within a tent located at some little distance from the stream on the banks of which the orchid grew. Examination of a considerable number of spikes showed that pollinia had been removed from many of the flowers, but actual removal by mosquitoes was not observed. Mosquitoes were extremely abundant, only a relatively small number was examined and few carried pollinia, but the impression remains that this undetermined species of mosquito may be regarded as of some importance as an agent in the pollination of this *Habenaria.*

This observation was recorded in *The Plant World,* 3: 6, January, 1900.

C. S. CRANDALL

UNIVERSITY OF ILLINOIS

PLUS AND MINUS AGAIN

DR. HALSTED'S statement[1] on the use of the symbol + in Widman's arithmetic of 1489 is apparently in conflict with my own.[2] As neither Widman's book nor the descriptions of it in the *Bibliotheca mathematica*[3] are readily accessible to most American readers, it may be well to give a fuller account. The

[1] SCIENCE, May 30, 1913, p. 837.

[2] SCIENCE, April 18, 1913, p. 610.

[3] 3. F., Bd. 9, 1908–09, pp. 155–157, 248; Bd. 10, 1909–10, pp. 182, 183.

statement that, with Widman, + meant simply "und" (and) is correct as a description of Widman's general usage. There is just one exception. Once, but only once, does Widman in his book identify + with "meer" (mehr). It is in the passage quoted by Dr. Halsted, "was auss — ist, das ist minus . . . vnnd das + das ist meer." It occurs in the explanation of a small table of weights.

Widman does not use the word "plus"; his word for addition is "vnd." As stated before, with Widman + had not yet become a purely mathematical sign. In his arithmetic (1489), as well as in a manuscript algebra in Latin, which he owned, + is used for "vnd" or "et" even in cases where "vnd" or "et" do not mean addition, as in the heading, "Regula augmenti + decrementi." It is interesting to note that he uses the word "minus" only twice in his book, and only once in the sense of —. Hence, in Widman, the words "plus" and "minus" do not occur as ordinary terms for addition and subtraction. The symbol + is often used for addition; — is used for subtraction at times, but not regularly. Apparently, the regular association of + with "plus," and — with "minus," came after Widman.

A further study of manuscripts and early printed books may throw more light upon the origin of + and — (as well as upon the first use of the decimal point), but the evidence now at hand goes against Dr. Halsted's claim that the + and —, used in the sense of $\pi = 3.14+$ and $\pi = 3.1416-$, "is historically the first meaning of the signs + and —, which arose from the marks chalked on chests of goods in German warehouses, to denote excess or defect from some standard weight." That they were so used is not denied, but the facts do not warrant the categorical statement that this "is historically the first meaning." No evidence has been adduced to establish the early use of + and — as marks chalked on chests. In the Bamberger Rechenbuch (1483) the tare to be deduced from the gross weight of a package is called "Das Minus," but the symbol — is not used. On the other hand, the regular connection of + with "vnd" in Widman's book of 1489 is unmistakable; the resemblance of + with the "et" of Latin manuscripts of the fourteenth and fifteenth centuries rests upon independent paleographic researches carried on by several writers mentioned by Cantor and Tropfke.

Florian Cajori

Colorado College

AN INSTITUTE FOR BIBLIOGRAPHICAL RESEARCH

The writer has from time to time tried to interest librarians, bibliographers and men of science in the matter of bibliographical research and publication, or rather in organized work along these lines, in the hope that a concerted movement in its favor might be brought about—but in vain. Men of wealth have also been approached, but so far the man who would see his opportunity and endow this important work has not been found.

An effort is now being made to interest business men in the subject. Special emphasis has lately been laid on the value of an institution for the organization of bibliographical research in the interest of agriculture, manufacture and commerce. A prospectus has been sent out to a number of business men in Chicago calling attention to the value of research along these lines for both agriculture, manufacture and commerce. A "Committee on Research Institute" has been formed for the purpose of promoting the idea.

While the latest endeavor has been made along the line of business, the intention of the writer is now, as it has always been, that the only limits to the scope of the proposed institute should be the actual needs of those who might seek its assistance. The functions of the proposed research institute would be entirely practical. The institute staff would be in readiness to make researches into definite subjects at the request of those desiring special information; it would also try to anticipate the needs of inquirers and compile references on subjects of actual interest in advance of demand.

It has been estimated that a sum of $50,000, or a guaranteed income of $10,000 a year for five years, would place the institute on a basis

firm enough to promise permanency. The institute would, it is expected, soon become in part self-supporting.

The writer has often been asked what relation this proposed bibliographical institute would have to the other institutes of this kind, notably the Institut International de Bibliographie at Brussels, and the Internationales Institut für Sozialbibliographie, and allied institutions, at Berlin. The answer is that it would supplement them and, as far as possible, utilize their material. The Brussels institute collects titles of all kinds, from all sources and of all dates, the Berlin institutes collect titles from the current year on a limited number of sciences. The institute which the writer proposes would have for its object to collect titles from all sources and of all dates on a definite number of subjects, concerning which information is actually wanted.

If anybody who reads the above should be willing to assist in any way in furthering the interest of bibliographical research along the lines suggested, he should communicate with the undersigned.

AKSEL G. S. JOSEPHSON, *Chairman, Committee on Research Institute*
THE JOHN CRERAR LIBRARY,
CHICAGO

SCIENTIFIC BOOKS

Elements of Physics. By E. H. HALL. Henry Holt & Co. Pp. 570.

A First Course in Physics. By MILLIKAN and GALE. Revised version. Ginn & Co. Pp. 430.

Applied Physics for Secondary Schools. By V. D. HAWKINS. Longmans, Green & Co. Pp. 196.

In a new text which may be looked on as a successor to Hall and Bergen's "Textbook of Physics," Professor Hall has incorporated many changes which have been suggested by discussions carried on in SCIENCE and in meetings of the American Association for the Advancement of Science. These changes are seen in the arrangement and treatment of mechanics and they tend toward the simplification of that subject. Mechanics is treated more fully in this text than in other elementary texts. The author has attempted to make the subject of the text deal with the experiences of the every-day life of the student. He has done this without introducing material and illustrations intended to make the book self-advertising, material which now figures in a number of texts. For this the text is to be commended.

The criticisms which many teachers will make are: that the text is much too full of details, that general principles do not stand out, and that the treatment is at times too didactic. How many students beginning physics are apt to understand or become enthused over this sentence on page 401, "Two conductors are said to be at the same electrical potential when the potential energy of a quantity of electricity on one is just as great as the potential energy of an equal quantity of electricity on the other, so that there is no flow of electricity from one to the other when they are connected by a conductor"? This is an unnecessarily heavy statement.

In attempting to bring in matter connected with the every-day life of the student the text has been burdened with detail. Its five hundred and seventy pages (seventy of which deal with laboratory exercises) may be regarded as encyclopedic for an elementary student.

The well-known and widely-used elementary text by Millikan and Gale has been revised, shortened by sixty pages, and improved in treatment. It is still, in its numerous details, a comprehensive text for elementary students, but it is interesting, original and up to date in subject matter. The authors aim to do away with the didactic method, yet in some of their abbreviated statements of general principles they do not accomplish this aim. To give only one example; in the deduction of the formula giving the object distance and image distance from a lens, they are content to state that a lens changes the curvature of a wave-front always by the same amount. This statement must appear an arbitrary one to a student, but had it been led up to by a

geometrical construction, as has been done by numerous teachers, it would appear more reasonable.

The two-thousand-year-old physics of Archimedes is a part of every text. That many developments in the domain of physics have been made in recent years is also generally recorded. But what physicist of ten years ago would have prophesied that the path of a helium atom could and would be photographed? And what must be the astonishment of even Mr. Wilson—whose patience and skill achieved this brilliant result—when he sees in the frontispiece of this elementary text published a few months after he did his work a reproduction of the photographs he obtained.

It is an extraordinary thing that some of the great facts of science, so difficult to obtain in the first case, are so easily understood after they have been obtained. The authors have eclipsed all others, as far as the reviewer knows, in their inclusion of new and striking developments in physics.

There is one general criticism which applies to this text and to several others. They introduce the student to the subject of physics by a study of liquids. The argument is that this study is fascinating. If that argument were to apply throughout the subject we would begin electricity with the discharge of electricity through gases, we would come to light through spectrum analyses and soap-bubble colors. The fascination which these phenomena have for students would be none the less if they were introduced in their logical place. The custom of placing the study of liquids first implies that a boy knows more about rowing or sailing a boat than he does about pulling an express-wagon or coasting on a sled; in general, that he is more at home in water or on water than on land. It may be that high-school laboratories are better equipped to show experiments setting forth the properties of liquids than experiments demonstrating motions and forces. But that does not alter the fact that force is a more elemental thing than pressure. Nor does it alter the fact that boys have a great fund of knowledge—unclassified, of course—in regard to motion and force, which knowledge can at once be made use of by a capable teacher.

It is interesting to compare the text written by Mr. Hawkins for technical high schools with the other texts arranged for general students of physics. In this text the student meets in the first chapter the difficult topics: machines, horse-power, and the Prony-brake. Later he begins the subject of electricity by the study of the dynamo. He continues this study to the performance of transformers, multiple generators, induction motors, etc. Evidently the technical high-school student must be prepared to assimilate strong food. Evidently, too, where facts of value to the commercial world are given large prominence, there is not much room for the discussion of scientific principles. For example, the experiment on the mechanical equivalent of heat is not described. Ohm's law is based on the definition of a volt! These but illustrate the criticisms which a physicist would make on the text. It does not give enough space to the presentation of the scientific method. But it does present in brief compass the main points at which physics touches commerce.

A Textbook of Physics. By Hurst and Lattey. Van Nostrand Co. In three volumes. Vol. I., Dynamics and Heat; Vol. II., Sound and Light; Vol. III., Heat, Magnetism and Electricity; a total of 640 pages.

This text is characteristic in places by its very elaborate and detailed explanations—the discussion of the passage of a beam of light through a prism takes up five pages—carried out into all the geometrical and arithmetical details. The problems are very numerous and are always identified as having been set in a certain examination. An American student may wonder why it is necessary to identify so highly original a question as this: "Describe shortly how a mercury thermometer is made. (Camb. Loc. June, '07.)" One sees that it is not the question, but the examination that is the principal thing. This text would be a very complete guide to a student going up for the army or university examinations.

Laboratory Problems in Physics. By JONES and TATNALL. Macmillan Co. Pp. 81.
Physical Laboratory Guide. By FREDERICK C. REEVES. American Book Co. Pp. 183.
A Course of Elementary Practical Physics. By H. V. S. SHORTER. Clarendon Press, Oxford. Part I., Mensuration, Mechanics, Hydrostatics. Pp. 110. Part II., Heat and Light. Pp. 216.

Jones and Tatnall's text contains outlines of about seventy-five experiments in general physics of secondary school grade. Some of the experiments are qualitative, such as are usually given in demonstrations in the class-room. Their inclusion would tend to make a laboratory course more interesting and less an exercise in following directions than most laboratory courses in physics are apt to be. The experiments are very briefly but clearly outlined and are well proportioned among the various parts of the subject. The text is named "Laboratory Problems," rather than "Laboratory Manual," probably on account of the fact that emphasis is placed upon the experimental problem, the principle or fact involved. In keeping with this idea, the outline of an exercise after giving a few brief directions (in very short sentences) consists of a series of questions tending to sharpen the student's powers of observation and reasoning. This is a most commendable feature of the text.

Mr. Reeves, an electrical engineer who is also a teacher of physics, has written a manual which places larger emphasis upon some experiments bearing upon engineering than do most manuals in physics. One evidence of this influence is seen in the fact that electricity (and magnetism) is given considerable space (from pages 23 to 59) almost at the opening of the text. Thirteen pages, an unusual amount of space, is given to Archimedes's principle with its application to the measurement of density and specific gravity. The chapter on the mechanics of *solids* opens with an experiment on the bending of beams and closes with the verification of Boyle's law!

The course which has been given by Mr. Shorter for several years at King Edward VIII. School, Sheffield, differs from that given in similar American schools in the larger space given there to mensuration. The volumes outlining the course consist of questions or directions with large blank spaces between—a cross between a series of report sheets and a laboratory manual. The spaces are rather small for the report sheets and the questions and directions rather attenuated for a manual. The heuristic method is rather overdone.

An Introduction to Mathematical Physics. By R. A. HOUSTOUN. Longmans, Green & Co. Pp. 197.

In less than two hundred pages Dr. Houstoun presents those ancient and honorable theorems in mathematical physics which English university men look upon as essential to the training of a physicist, but which look rather formidable to most students of physics in American colleges. The text starts in with the theory of attraction and potential, Gauss's theorem, Laplace's and Poisson's equations, and electrical images. It continues through hydrodynamics, Green's theorem, irrotational motion, Stokes's and Kelvin's theorems, Fourier's series with application to the conduction of heat, wave motion with application to acoustics and tidal waves, electromagnetic theory with application to the reflection and refraction of radiation, and lastly, thermodynamics with applications to reversible cells. It is a matter of wonder that a text so small can contain so much. Most physicists will feel that the experimental point of view should have had a larger place—for example, that descriptions should have been given of harmonic analyzers and synthesizers, of sound analyzers, of wave meters, and that it should have included the telegrapher's equation. The problems, too, might have been chosen with more thought of the actual and less of the geometric and ideal. But we can not have everything in two hundred pages.

DARTMOUTH COLLEGE G. F. HULL

Die Steinzeitliche Technick und Ihre Beziehungen zur Gegenwart. Ein Beitrag zur Geschichte der Arbeit von DR. LUDWIG

PFEIFFER, Geh. Med.-Rat. in Weimar, with 250 Original-Abbildungen. Jena, Verlag von Gustav Fischer. 1912.

Dr. Pfeiffer has produced an important work on the stone art in which he has not only detailed his own extensive researches on the subject, but has brought together the results found in the scattered and often inaccessible publications which have appeared from time to time. It is encouraging to workers that his enthusiasm has not been dampened by the difficulty of encompassing so vast a subject, the most part of whose materials are buried (archeological) and the rest only fragmentarily studied (ethnological culture history). If we regret that the historians of the past have not recorded for us the methods of ancient arts, so do we also mourn that there were not more of the thorough workers like Holmes, Mason, McGuire, Cushing, Roth and others, to undertake the study of present man before he lost his inherited art.

Dr. Pfeiffer remarks in his preface that organized labor goes farther back than has been supposed and that in the immensely long period before metals, man had manufactured implements and discovered processes for a definite purpose and in so doing developed industries and the tools necessary to carry them on. The work concerns the stone age up to the time of the beginning of the technical age when bronze, hard bronze and iron took the place of stone, the latter age small compared with the million years that flint dominated. He believes that the tools that have survived to us show a progressive modification as a result of their transmittal from earlier to later social units, the changes marking the phases of culture which in European archeology are practically established. The most important material covered by the monograph is naturally flint, but Dr. Pfeiffer does not lose sight of the industries connected with wood, skin and other softer materials.

The subject is so fascinating that excursions into it are almost irresistible and with some slight knowledge of the complexity of the study and the liability to error we must honor the efforts of those who are the pioneers. The problems are not simple, it is not enough to know how the American Indian made an arrowhead—there are 20 ways, or to set it on its shaft—there are many ways. A study of the mute point in a museum is good, but a study of the mind of primitive man correlated with its environment is necessary before we can loose the scientific imagination on its quest. We must manipulate the substances ourselves; we must unravel and weave again until the possibilities are exhausted so far as our limits are concerned, going again and again to the man in the hinterland of civilization and hoping, also, that some survival can be wrested from bog or cave to give us light.

The chapters are seven, as follows: (1) The History of Technic in the Stone Age, Treating of the Time Element; (2) The Physical Basis of Stone Technic; (3) The Products; (4) The Stone Age Bone Work; (5) The Stone Age Wood Work; (6) Animal Industry; (7) The Extinction of the Stone Art.

The subheadings of subjects treated under the chapters number 59 and form an interesting synopsis.

WALTER HOUGH

Psychology and Industrial Efficiency. By HUGO MÜNSTERBERG. Boston and New York, Houghton Mifflin Company. 1913. Pp. 321. $1.50 net.

There are three varieties of books on applied psychology. To the first variety belongs the intensive monograph in which is reported some attempt to utilize the methods of experimental psychology in the detailed investigation of some limited problem of general and practical importance. This variety is represented by Thorndike's studies in the quantitative measurement of school progress. A second variety attempts directly to apply the generalizations of psychology to some particular field of daily life, and is represented by Scott's books on psychology and business. Books of the third variety are designed primarily to stimulate general interest in the possible serviceableness of the science and to suggest various directions which this service may

take at some future time. Of these three types the first is the most rare, the second the most familiar and the third the most popular. Professor Münsterberg's book belongs to the third type, and its popularity is indicated by the fact that during the month of April it was reported among the six best selling non-fiction books in the largest cities of Maryland, Massachusetts, Illinois, Michigan, Florida, Minnesota and New York, along with "The New Freedom," "The Promised Land," the Montessori books, "Zone Policeman 88" and "Auction Bridge of To-day."

The book contemplates the ultimate development of a science of "psychotechnics" which shall handle the problems of industry and economics by the application of the technique of experimental psychology. The various chapters give a series of interestingly presented illustrations of the psychotechnic point of view, the selection of examples being confined to those fields of industry which have not yet been systematically explored by applied psychology.

Tests for vocational guidance; methods of scientific management; elimination of unfit individuals from railway, ship and telephone service; economy of movement; fatigue and monotony; types of attention; the influence of weather, drugs, entertainment, rhythm, and other physical and social factors; the effectiveness of advertisements; illegal imitation; buying and selling;—all these topics, and similar ones, are discussed from the point of view of the three problems—"How to find the best possible man, how to produce the best possible work and how to secure the best possible results." Preliminary experiments are described and the work of other workers briefly summarized. The author frequently remarks that most of the experiments represent only the beginnings of investigations, which, it is hoped, will in time yield significant and useful results.

Of particular interest is the author's recognition of the importance of interests, inclinations and emotional attitudes, and of the desirability of devising tests which will measure an individual's ability to grasp a general situation. Tests of this sort will doubtless prove to be of much greater diagnostic value than the simple sensori-motor measurements. More complete data are promised in forthcoming reports of detailed investigations now being carried on in the author's laboratory. These reports will presumably belong to the rare first variety of monographs, and will be looked forward to with interest by professional psychologists to whom the present book constitutes not so much a contribution as a challenge to fulfil the prophecies of a fellow worker. Perhaps the most immediate value of the book comes from the ingenuity with which its problems are conceived and the preliminary tests devised. Professor Münsterberg's hopefulness for the future possibilities of "psychotechnics" does not keep him from placing a commendably conservative value on the actual results and correlations of his own preliminary studies.

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SPECIAL ARTICLES

THE EMISSION OF ELECTRONS FROM TUNGSTEN AT HIGH TEMPERATURES: AN EXPERIMENTAL PROOF THAT THE ELECTRIC CURRENT IN METALS IS CARRIED BY ELECTRONS

THAT the carriers of the negative thermionic current from incandescent solids are negative electrons was first established by J. J. Thomson.[1] In 1901[2] the writer developed the view that this emission of negative electrons occurred by virtue of the kinetic energy of thermal agitation of some of the electrons in the solid exceeding the work which was necessary to overcome the forces which tend to retain them in the body and which prevent them from escaping at lower temperatures. This conception has proved a very fruitful one and its consequences have been verified in a number of ways. It has provided a quantitative explanation of the variation of the number of electrons emitted with the temperature of the body. It led to the prediction of a cooling

[1] *Phil. Mag.*, Vol. 48, p. 547 (1899).

[2] *Camb. Phil. Proc.*, Vol. 11, p. 286 (1901); *Phil. Trans.*, *A*, Vol. 201, p. 497 (1903).

effect when electrons are emitted by a conductor and a corresponding heating effect when they are absorbed. Both these effects[3] have since been detected experimentally and found to be of the expected magnitude, within the limits of experimental error. The magnitude and distribution of energy of the emitted electrons has been found by experiment to be that given by Maxwell's law,[4] in accordance with the requirements of the theory. Finally, the same general train of ideas has led to valuable applications in the direction of the theory of metallic conductors,[5] contact potential[6] and photoelectric action.[7]

It has long been known that ions are emitted in a number of cases in which solids react chemically with gases. The recent experiments of Haber and Just[8] indicate that the alkali metals liberate electrons when they are attacked by certain gases. It seems likely, from various considerations,[9] that effects of this nature would account for most of the emission from heated sodium which was measured by the writer.[10] In consequence of this conclusion, together with the results of a number of experiments which are at first sight in conflict with the theory referred to at the beginning of this paper,[11] the view appears to have become rather prevalent that the emission of electrons from hot bodies is invariably a secondary effect arising in some way from traces of chemical action. That this view is a mistaken one is, I think, conclusively shown by the following experiments which I have made with tungsten filaments.

The tests to be described were made with experimental tungsten lamps carrying a vertical filament of ductile tungsten which passed axially down a concentric cylindrical electrode of copper gauze or foil. The tungsten filaments were welded electrically in a hydrogen atmosphere to stout metal leads. These in turn were silver soldered to platinum wires sealed into the glass container. The lead to the copper electrode was sealed into the glass in the same way. The lamps were exhausted with a Gaede pump for several hours, during which time they were maintained at a temperature of 550–570° C. by means of a vacuum furnace. The exhaustion was then completed by means of liquid air and charcoal, the tungsten filament meanwhile being glowed out by means of an electric current at over 2200° C. Most of the tests were made after the furnace had been opened up and the walls of the lamps allowed to cool off. They were always considerably above the temperature of the room on account of the heat radiated by the glowing filament.

The processes described are extremely well adapted for getting rid of the absorbed gases and volatile impurities which form such a persistent source of difficulties in experiments of this character. Unless some such treatment is resorted to, the metal electrodes and glass walls of these tubes continue to give off relatively large amounts of gas under the influence of the heat radiated from the filaments and it has always been possible that this evolution of gas might have played an important part in the electronic emission. The mode of treatment used, for which I am largely indebted to the experience and suggestions of Dr. Irving Langmuir, of the General Electric Company's Research Laboratory at Schenectady, N. Y., seems very superior to anything in this direction which has previously been published.

Tests have been carried out covering the alternative hypotheses as to the possible mode

[3] Richardson and Cooke, *Phil. Mag.*, Vol. 20, p. 173 (1910), Vol. 21, p. 404 (1911); Cooke and Richardson, *Phil. Mag.*, Vol. 25, p. 624 (1913).

[4] Richardson and Brown, *Phil. Mag.*, Vol. 16, p. 353 (1908); Richardson, *Phil. Mag.*, Vol. 16, p. 890 (1908); Vol. 18, p. 681 (1909).

[5] Richardson, *Phil. Mag.*, Vol. 23, p. 594 (1912); Vol. 24, p. 737 (1912).

[6] Richardson, *Phil. Mag.*, Vol. 23, p. 263 (1912).

[7] Richardson, *Phil. Mag.*, Vol. 24, p. 570 (1912); Richardson and Compton, *Phil. Mag.*, Vol. 24, p. 575 (1912).

[8] *Ann. der Phys.*, Vol. 30, p. 411 (1909); Vol. 36, p. 308 (1911).

[9] Cf. Fredenhagen, *Verh. der Deutsch. Physik. Ges.*, 14 Jahrg., p. 384 (1912); Richardson, *Phil. Mag.*, Vol. 24, p. 737 (1912).

[10] *Phil. Trans., A*, Vol. 201, p. 497 (1903).

[11] Cf. Pring and Parker, *Phil. Mag.*, Vol. 23, p. 192 (1912).

of origin of the electronic emission which are enumerated below:

1. The emission is due to the evolution of gas by the filaments.

The lamp and McLeod gauge were cut off from the rest of the apparatus by means of a mercury trap, the volume being then approximately 600 c.c. A filament 4 cm. long giving a thermionic current of .064 amp. was found to increase the pressure from zero to $< 1 \times 10^{-6}$ mm. in five minutes. The number of molecules N_1 of gas given off is therefore $< 2.13 \times 10^{13}$. The number of electrons given is $N_2 = 1.2 \times 10^{20}$. The number of electrons emitted for each molecule of gas evolved is thus $N_2/N_1 > 5.64 \times 10^{6}$.

In the above experiment a liquid air trap was interposed to keep the mercury vapor off the filament. In another experiment with a filament 8 cm. long this was not the case and with a current of .050 amp. the pressure rose in thirty minutes to a value which was too small to measure, but which was estimated as less than 10^{-7} mm. The corresponding value of N_2/N_1 is 2.6×10^{8}. In this case the current was unaffected when the mercury vapor was subsequently cut off by liquid air (a change of 0.4 per cent. would have been detected).

The magnitude of the above numbers effectually disposes of the idea that the emission has anything to do with the evolution of gas.

2. The emission is caused by chemical action or some other cause depending on impacts between the gas molecules and the filaments.

In a tube with a filament 1.4 cm. in length and having 1.65×10^{-2} cm^2 superficial area the pressure rose to $< 2 \times 10^{-6}$ mm. in 5 minutes with an emission of .050 amp. If the gas is assumed to be hydrogen, which makes most impacts, using a liberally high estimate of the temperature of the copper electrode which determines the temperature of the gas, I find that the maximum number N^1 of molecules impinging per second during this interval would be $< 7.0 \times 10^{13}$. The number of electrons emitted per second would be $N_2 = 3.13 \times 10^{17}$. The ratio N_2/N^1 is thus $> 4.47 \times 10^{3}$. If the putative hydrogen atoms simply turned into a cloud of electrons whose total mass was equal to that of the hydrogen the value of N_2/N^1 would be only 3.68×10^{3}. The data already referred to for the tube with the filament 8 cm. long give an even larger ratio for N_2/N^1, namely, 1.57×10^{4}. Moreover, in some of our experiments the changes in gas pressure were much larger than those recorded above, but they were never accompanied by any change in the electronic emission: also the admission of mercury vapor at its pressure (about 0.001 mm.) at room temperature produces no appreciable change in the emission. Thus there is no room for the idea that the emission of electrons has anything to do with the impact of gas molecules under the conditions of these experiments.

3. The emission is a result of some process involving consumption of the tungsten.

To test this question some of the lamps were sealed off after being exhausted in the manner described. The filaments were then heated so as to give a constant thermionic current which was allowed to flow for long intervals of time. In this way the total quantity of negative electricity emitted by the filament was determined. The wire was placed in one arm of a Wheatstone's bridge so that the resistance could be recorded simultaneously. The cold resistance was also checked up from time to time.

At these high temperatures the resistance of the filaments increases slowly but continuously. This increase is believed to be due to evaporation of the tungsten. It was found to be proportional to the time of heating when the thermionic current was kept constant, in the case of any particular filament. In the case of one filament which gave 0.05 amp. for 12 hours the increase in the resistance of the hot filament was 9 per cent. The accompanying proportionate increase in the cold resistance was slightly lower, namely, 7 per cent. The latter may probably be taken as a fair measure of the amount of tungsten lost by the filament. The increase in resistance of the hot filament, which is less favorable for our case, will be considered instead

in the following experiment for which the other data are lacking.

A filament 3 cm. long gave 0.099 amp. electronic emission continuously for 2.5 hours. The resistance when hot rose from 4,773 to 4,787 in arbitrary units. The number of atoms of tungsten lost by the filament in this time was $= 5.66 \times 10^{15}$, whilst the number of electrons emitted $= 5.57 \times 10^{21}$. The number of electrons emitted per atom of tungsten lost was 9.84×10^{5}. The mass of the electrons emitted in this experiment was thus very close to *three times* the mass of the tungsten lost by the filament.

This tube gave 0.1 amp. electronic emission on the average for 6 hours altogether. By that time the mass of the electrons emitted was approximately 2 per cent. of the mass of the tungsten filament. The tube came to an end owing to an accident: the filament gradually became deformed until it touched the copper electrode and broke. The hardness of the tube was then tested with an induction coil and the equivalent spark gap was found to be 3.3 cm. The discharge through the tube gave a bright green fluorescence on the glass around the negative wire, but there was no indication of a glow or the faint purple haze which is obtained when traces of gas are present in tubes of this kind. There is thus no appreciable accumulation of gas even when the filaments are allowed to emit a large thermionic current continuously for a long time.

Another tube with a wire 2.7 cm. long, giving 0.050 amp., lost 1.19×10^{17} atoms of tungsten in 12 hours as measured by the change in the cold resistance. The number of electrons emitted for each atom of tungsten lost was thus 1.13×10^{5} and the mass of the emitted electrons about one third of the mass of the tungsten lost. This tube ran altogether for about 23 hours, giving various currents, and finally gave out, owing to the local loss of material near one end, caused by the sputtering or evaporation. Local over-heating is very apt to occur in these experiments as the thermionic leakage causes the heating current in the wire to be bigger at one end than the other. The mass of all the electrons emitted by this filament was equal to 4 per cent. of its total mass. Under a low-power microscope the filament did not appear to be much changed except in the region where it had burnt out, where it was much thinner than elsewhere.

There is no known reason for believing that the loss of tungsten is due to anything more profound than evaporation. But, in any event, the fact that the mass of the emitted electrons can, under favorable circumstances, exceed that of the tungsten loss proves that the loss of tungsten is not the cause of the electronic emission.

4. The only remaining process of a similar nature to those already considered which has not been discussed is the bare possibility that the emission is due to the interaction of the tungsten with some unknown condensable vapor which does not affect the McLeod gauge. This possibility is cut out by the fact that the thermionic emission is not affected when the liquid air and charcoal is cut off and the vapors allowed to accumulate in the tube, and by the fact that very considerable changes in the amount and nature of the gases present (as by the admission of mercury vapor) have no effect on the emission.

Taken together these experiments prove that the emission of electrons does not arise from any interaction between the hot filament and surrounding gases or vapors nor from any process involving consumption of the material of the filament. It thus follows that the emission of electrons from hot tungsten, which there is no reason for not regarding as exhibiting this phenomenon in a typical form, is not a chemical but a physical process. This conclusion does not exclude the possibility that, under other circumstances, electrons may be emitted from metals under the influence of various chemical reagents, a phenomenon which would be expected to exhibit the same law of dependence upon temperature; but it does involve a denial of the thesis that this emission is invariably caused by processes involving changes of material composition.

The experiments also show that the elec-

trons are not created either out of the tungsten or out of the surrounding gas. It follows that they flow into the tungsten from outside points of the circuit. The experiments therefore furnish a direct experimental proof of the electron theory of conduction in metals.

I wish to express my appreciation of the assistance I have received from Mr. K. K. Smith, instructor in the laboratory, in the preparation of the tubes and in carrying out some of the measurements. Mr. Smith and I are engaged in a more detailed quantitative study of the emission of electrons from tungsten, the results of which we hope shortly to publish. I also wish to thank Dr. W. R. Whitney and Dr. I. Langmuir, of the General Electric Company, both for supplying the specimens of ductile tungsten used and also for giving me the benefit of their invaluable experience.

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MENDELIAN INHERITANCE OF EPIDERMAL CHARACTERS IN THE FRUIT OF CUCUMIS SATIVUS

THE fruits of the White Spine cucumber (*Cucumis sativus*) possess numerous white epidermal spines or trichomes which roughen the skin very markedly; while those of the Richard's Invincible, an English forcing type (var. *Anglica*), possess but few, small, indistinct, early-deciduous and black spines that scarcely roughen the skin. By crossing these varieties, the White Spine having been used as the maternal parent, there was obtained a type of fruit apparently intermediate in size and in number and prominence of the spines, with the exception that all the spines were black like the paternal parent. In the F_2 generation, of the twenty plants grown fifteen bore black spines and five white spines; six possessed smooth skins with indistinct spines like the Richard's Invincible and the remainder skins with various degrees of roughness—a few even surpassing the White Spine in the number of spines. No correlation of color of spines and roughness was noted—smooth-skinned progeny possessing white as well as black spines.

The inheritance of the color of the spines apparently follows the simple Mendelian segregation, although the number of progeny is too small for a very exact interpretation; the small number of smooth-skinned types also indicates this character as a recessive one, especially as the F_1 fruits show no evidence of this character. Practically, these data are of little value unless they indicate that by crossing back one of these smooth-skinned, white-spined fruits with an English variety, it would be possible to obtain a new white-spined variety, differing in appearance but slightly from var. *Anglica;* theoretically, it adds a little more evidence to the support of Mendel's universal law.

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POWDERY SCAB OF POTATOES IN THE UNITED STATES

IN a recent number of *Phytopathology* Professor H. T. Güssow, of Canada, Dominion Botanist, reported for the first time in America the occurrence of the well-known European "powdery" or "corky" scab of potatoes.[1] The specimens upon which he based this report were received first from Quebec, where the disease appeared to be well established in some counties. It was also recorded in isolated cases in widely separated regions of Canada, namely, Cape Breton, Nova Scotia, New Brunswick, Ontario and Alberta. These facts led Professor Güssow to suggest that probably the disease occurs in the United States.

In connection with certain studies now being carried on in the writer's laboratory upon the general subject of potato scab, requests for specimens of scabby tubers have been sent to many individuals representing widely separated localities in the state of Maine and also

[1] Güssow, H. T., "Powdery Scab of Potatoes, *Spongospora subterranea* (Wallr.) Johns.," *Phytopathology*, 3: 18–19, 1913.

to numerous friends and acquaintances in other parts of the United States. In asking for these specimens the fact was emphasized that potatoes affected by scab which differed in appearance from the ordinary type of the disease were especially desired.

As soon as received all lots of tubers were subjected to careful microscopic examination for the presence of *Rhizoctonia* and for the spore "balls" of *Spongospora subterranea* (Wallr.) Johns., or the fruiting bodies of the organism which is the cause of the powdery scab. None of the specimens showed the characteristic, superficial appearance of the last-named disease and the microscopic examination failed to establish its presence in any case beyond doubt, but practically all, regardless of the source, showed *Rhizoctonia* threads in the diseased areas. In addition poured plates were made from a large number of tubers from different sources and in every case tried the organism known as *Oospora scabies* Thaxter was isolated from some of the scabby spots.

A few of the tubers received showed small but rather pronounced pits upon their surfaces. Since these were usually more or less lined with *Rhizoctonia* threads it seemed possible that this fungus might be the primary or secondary cause of the pitting. Specimens of all lots of tubers of this kind and a considerable number of others, including samples from several different states, were planted in ten-inch pots in the greenhouse. Before planting the pots and soil were sterilized by heating for two hours under steam pressure at 20 pounds. The pots were then placed in sterilized saucers upon a raised, slat-work platform. The platform was constructed of new lumber and it and the bench upon which it rested had been previously washed with a strong solution of formaldehyde. The pots were watered with boiled water and all other precautions were taken to avoid cross infection or outside contamination.

The tubers from a part of these pots have just been harvested and in two instances rather surprising results were obtained in that in both well-developed and typical cases of powdery scab were found.[2] A careful reexamination of other tubers from the original lots of specimens, which are now badly dried out, was then made and these showed the presence of a small number of yellowish brown bodies, now considerably shrunken, but which are evidently the dried spore balls of the causal organism. One of the original lots was sent by Dr. George E. Stone from Massachusetts, while the other was received from Nebraska through the courtesy of Mr. W. A. Orton, of the Bureau of Plant Industry at Washington.

No conclusive evidence of the presence of powdery scab in other parts of the United States has been obtained, but tubers which show a few bodies in the diseased areas which somewhat resemble those upon the tubers described above have been received from one locality each in Maine, Vermont and Wisconsin. These have recently been planted in pots in the greenhouse, but it will be some time before a final decision can be made.

The fact that the disease has been obtained from such widely separated localities as Massachusetts and Nebraska would indicate that it may be quite generally distributed in the United States and suggests the possibility that it may be a factor in the cause of potato scab in this country. In order to obtain farther light on this and on the subject of potato scab in general the writer of this note wishes to obtain specimens of scabby tubers from as many different localities as possible, and will gladly pay transportation charges on any which are sent in response to this request.

W. J. Morse

Maine Agricultural Experiment Station,
May 27

[2] Mr. M. Shapovalov, to whom credit should be given for carrying out a large part of the details of the work upon which this statement is based, isolated cultures of *Oospora scabies* from the two tubers which produced the crop affected with powdery scab. He has also demonstrated that the cultures thus obtained are capable of causing, upon inoculation, the typical form of scab which is associated with the last-named organism. Hence it is evident that both forms were present on both lots of tubers.

SCIENCE

FRIDAY, JULY 18, 1913

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE RELATION OF FORESTS IN THE ATLANTIC PLAIN TO THE HUMIDITY OF THE CENTRAL STATES AND PRAIRIE REGION

INTRODUCTION

MANY of the dreams or presentiments of the early scientists are now coming true every day. The dreams of the alchemists are now almost within the realization of modern chemistry. The gropings of the early biologists are almost within reach of present-day experimental embryology, and so on practically in every science; at first a presentiment, "a hunch," which can not be substantiated by any scientific facts. This, later, with the accumulation of more accurate observations is often entirely denied or minimized, only to reappear again, not as a presentiment any more, but as a scientifically established fact.

From the earliest times there existed among laymen, and even scientists, a belief that forests exercised an influence upon the climate of entire countries. With the introduction of accurate methods of meteorological observations, this popular conception has seemingly been greatly discredited. All that most of the meteorologists were willing to admit was that forests have a local influence upon climate, extending only over the territory actually occupied by them. Within recent years, just when this view seemed to be completely disposed of, many new facts came up independently in different countries, which point strongly to the possibility of the forest exerting a potent influence upon the humidity of regions lying far away from it. I shall attempt to consider in the light of these new facts the conditions prevailing in the eastern part of the United States, and to es-

tablish a relation between the forests of the coastal plain and the southern Appalachians, on the one hand, and the humidity of the central states and prairie region, on the other.

There are three fundamental facts upon which, in my judgment, this relation is based.

1. In the eastern half of the United States there is a marked periodicity in the wind direction. In winter the prevailing winds are from the north and northwest; in summer the prevailing winds are from the south. When the prevailing winds come from the south the entire eastern half of the United States is wet. When the prevailing winds are from the northwest and west the precipitation decreases. Therefore, the precipitation of the eastern half of the United States depends largely upon the prevailing southerly winds which come from the Gulf and penetrate far into the interior of the continent.

2. The evaporation from the ocean plays a comparatively unimportant part in the precipitation over the land; *seven ninths* of the precipitation over land is supplied by evaporation over the land itself and only two ninths is furnished by the evaporation from the ocean. Therefore, the greater the evaporation from the land which is in the path of the prevailing southerly winds, the more moisture must be carried by them into the interior of the continent.

3. The forest evaporates more water than any vegetative cover and much more than free water surfaces. Therefore, forests enrich with moisture the winds that pass over them and contribute to the humidity of the regions into which the prevailing air currents pass.

PERIODICITY OF WIND DIRECTION IN THE EASTERN HALF OF THE UNITED STATES

After Asia, North America is the largest continent in the world. One of the most striking physiographical features of North America is that the mountains run along the meridians and not along parallels. The entire northern part of the American continent has no high mountains except in the western part. As the result of this the central part of the continent does not offer any obstruction to winds from the 30th to 70th degree of northern latitude, that is, from the Gulf of Mexico to the Arctic Sea. Even the Asiatic continent does not have such a large continuous area free of mountains extending along the meridian. There the greatest extension is from the 38th to the 73d degree of northern latitude, that is, from the southern border of the plain of Touran to the northern shores of western Siberia. To the south of the 30th degree extend the waters of the Gulf of Mexico. The mountains on the southern shore of the gulf begin only at 19 degrees of north latitude. The North American continent, therefore, together with the interior lakes forms an expanse for the movement of the air between the tropical and Arctic regions, such as is found outside of it only on large oceans, in the northern hemisphere, on the Atlantic Ocean.

Another climatic peculiarity of the eastern United States which has a bearing upon the question under discussion is the rapid decrease in temperature from south to north. Take, for instance, Labrador; it is entirely an Arctic region where agriculture is impossible. Yet it lies in latitudes at which in Europe and Asia agriculture is still flourishing and large populous cities are found (in 53d to 60th degree northern latitude are found Christiania, St. Petersburg). Florida, on the other hand, between 25th and 30th degree of north latitude, is almost a tropical country. Between Florida and Labrador the drop of temperature for each degree of latitude (60 miles) is for January 2.9° F., for July 1.08° F. and for the entire year 1.7° F.

Comparing the same latitudes in Europe the drop for each degree of latitude is less than half of that for the North American continent. Between the Canary Islands and northern Scotland the decrease in the mean annual temperature for one degree of latitude is only 0.8 of a degree.

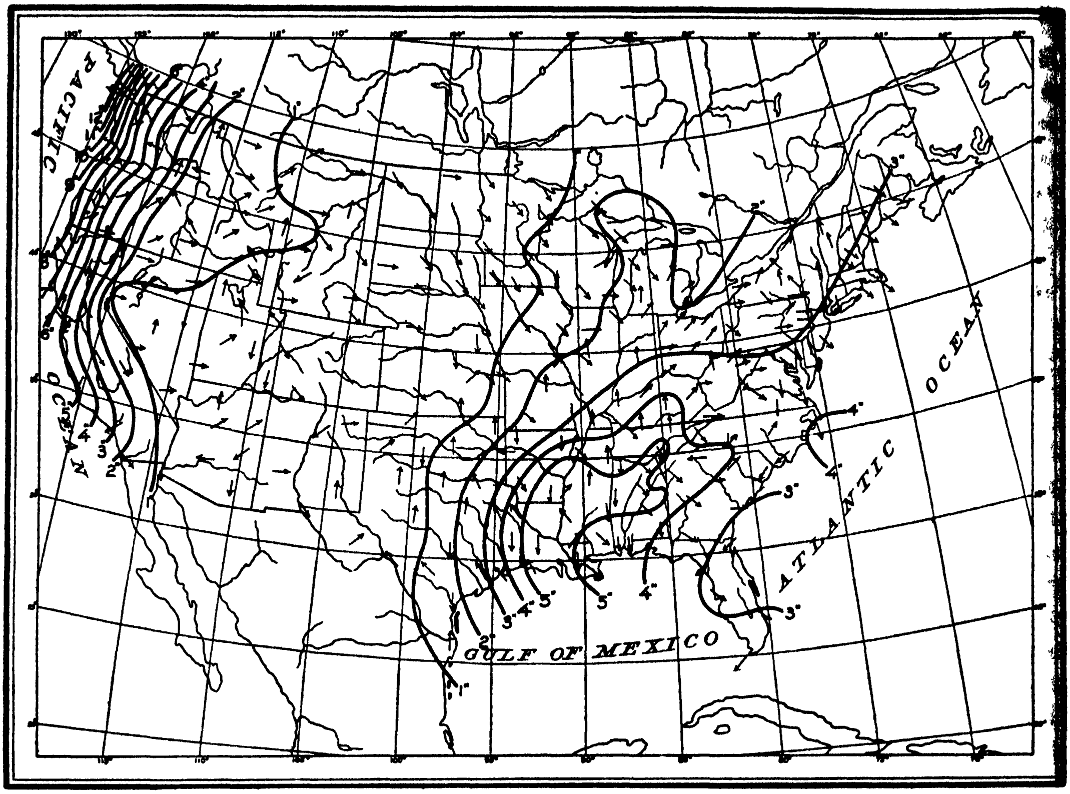
Climatically the North American continent can be divided into three parts:

1. The narrow strip along the Pacific Ocean, which is separated from the interior of the continent by mountain ranges. This narrow strip from the Peninsula of California to the southern shore of the Peninsula of Alaska, from the 32d to the 60th degree of northern latitude, is under the influence of the Pacific Ocean, as it is open to the west, while in the east high mountains separate it from the interior of the continent; and as western winds are, as a rule, the strongest winds in the northern hemisphere, it is only natural that westerly and northwesterly winds prevail in this part of the country both in summer and winter.

2. The region of mountains and plateaus to the east of the Cascades and Sierra Nevada ranges. This extends not only to the Rocky Mountains, but beyond the Rocky Mountains to the 100th meridian. The high plateaus and the low valleys of this region are characterized by extreme dryness and only in the mountains does the snow and rain fall in any abundance. The dryness is due to the fact that the prevailing westerly winds give off the moisture on the western slopes of the Sierra Nevada and Cascades, and become dry winds on the leeward side of these mountains. During the winter the prevailing winds are from the west and northwest, but in the summer the direction of the wind changes considerably, becoming southwesterly. This change in the direction of the wind in summer has been observed even on Pikes Peak, but is still more pronounced in the valleys and on the plateaus.

3. Since the Appalachian Mountains do not offer a climatic boundary, the entire eastern part of the North American continent east of the 100th meridian can be considered climatically as one unit. This climatic region is the largest of the three, including the Atlantic plain, the Mississippi Valley, except the upper part of its western tributaries, and the Lake Region to the Hudson Bay. During winter and partly in the fall and in the early spring the winds in this region come from the west and northwest. These prevailing winds bring cold and comparatively dry air from the interior of the continent. In the spring and early summer these winds are hot and dry. In summer the prevailing winds are from the southeast in Texas, and farther north and east they come from the south and southwest. Professor Henry, in his "Climatology of the United States," says that in midwinter northwesterly winds prevail uniformly over the Missouri Valley and the upper and middle portions of the Mississippi Valley. As the spring advances the region of southeast to south winds spreads northward and eastward from the Texas coast, so that by April it embraces the states of Texas, Oklahoma, Arkansas, Mississippi, Louisiana, Alabama, western Tennessee, Missouri, Kansas, southeastern Nebraska and Iowa. By June the northwest winds of midwinter have been supplanted by southerly winds over practically the whole of the country east of the Rocky Mountains. In autumn the northwest winds become more frequent and as autumn shades into winter they gain the ascendency in the Missouri and Mississippi valleys and the plains states.

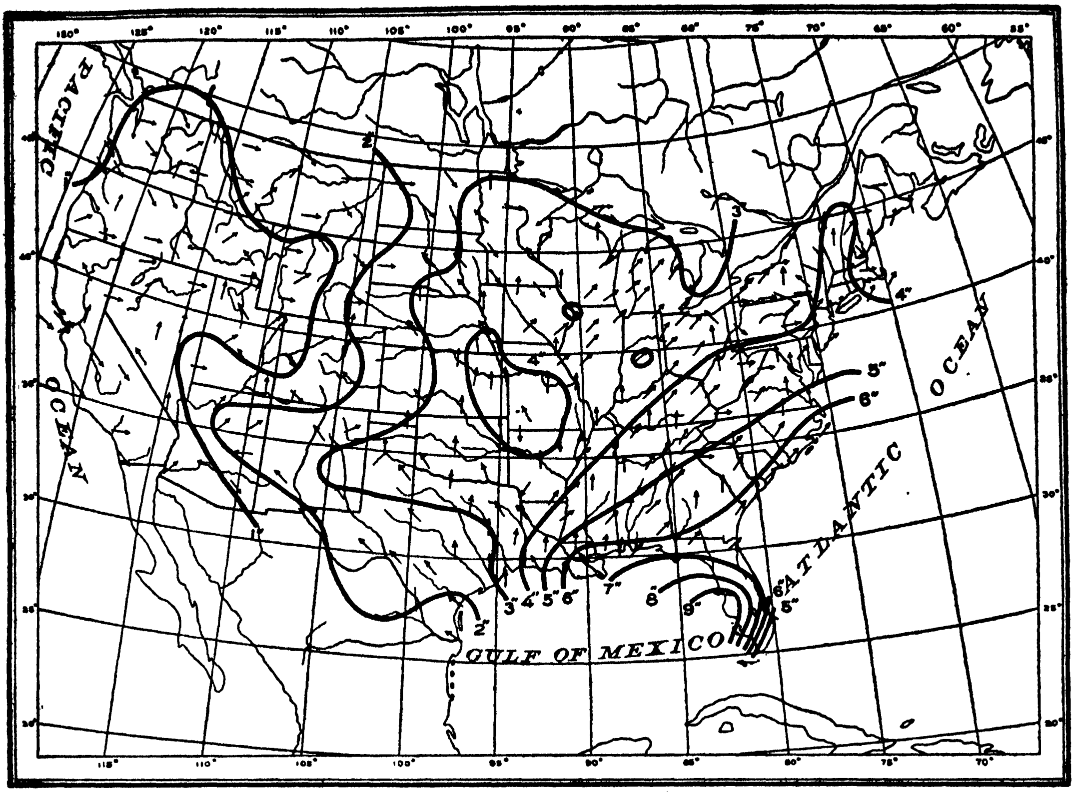
The periodicity is well illustrated on the two maps, on which is indicated by arrows



PREVAILING DIRECTIONS OF THE SURFACE WINDS AND THE MEAN PRECIPITATION IN THE UNITED STATES DURING JANUARY

the direction of the prevailing winds, based on twenty years of continuous records, and by lines the mean precipitation for the months of July and January. The map for the month of July is typical for the summer period and the one for the month of January is typical for the winter period. These maps show, very clearly, it seems to me, that the eastern half of the United States is under the influence of two prevailing winds; one, which originates in the Gulf of Mexico and in the Atlantic Ocean, is mild and humid; the other, which comes from the interior of the continent and from the Rocky Mountain region, is dry and continental in character, that is, dry and cold in winter and dry and hot in the spring and summer.

Another important fact which the records of precipitation and wind direction establish is that there is a most intimate relation between the prevailing southerly winds and precipitation in the eastern half of the United States. It is during the summer period when the entire eastern half of the United States is under the influence of the southerly winds, that most of the precipitation falls over it. On the plains east of the Rocky Mountains the summer rainfall forms from three fourths to four fifths of that of the entire year. In July when the southerly, southwesterly and southeasterly winds extend far into the interior of the continent as far north as North Dakota, and as far west as the foothills of the Rocky Mountains and



PREVAILING DIRECTIONS OF THE SURFACE WINDS AND THE MEAN PRECIPITATION IN THE UNITED STATES DURING JULY

even into eastern New Mexico, and as far east as New England, the precipitation over the entire eastern half of the United States is very heavy. In winter the picture of both wind direction and precipitation is radically changed. The northerly and northwesterly winds have not the same pronounced persistence as the summer winds. Yet through the entire south—Texas, Louisiana and Mississippi—as well as the Atlantic states, the lake states and the central states, the prevailing winds are northerly and northwesterly winds. At the same time there is a perceptible decrease in precipitation through the entire eastern half of the United States, and where in July there fell as much as three inches of rain, in January there is less than one inch, and where in July there fell as much as five inches there is in January less than two inches.

This increase and decrease in precipitation over the eastern half of the United States, with change in the direction of the wind, points to the fact that the eastern half of the United States depends for its moisture upon the prevailing southerly winds, which originate in the Gulf of Mexico and the Atlantic Ocean.

Professor Willis Moore, therefore, is entirely right, it seems to me, when he claims that the Pacific Ocean has little influence upon the precipitation of the eastern half of the United States, as Mr. Gannett and Mr. Bailey Willis have tried to prove. It is possible that some of the vapor that orig-

inates in the Pacific Ocean drifts over the tops of the mountains and during winter is drained of its moisture by the excessive cold. This moisure may be precipitated in the form of snow over such states as North Dakota, but the amount can not be very great.

The central interior region of the United States is thus the battleground of two titanic forces, of which one is harmful and the other is beneficial. The beneficial force takes its origin in the Gulf of Mexico and the adjoining ocean, the harmful in the interior of the continent and the Rocky Mountain region, and whether it comes as the warm chinook winds which blow out of the northern Rocky Mountains, or as the dry westerly winds of the upper Mississippi Valley and the western Lake region, occurring especially in the spring and early summer, it always carries in its wake serious injury to orchards and fields.

The central states and the prairie region are geographically at the point where the battle between the two forces is fiercest and the victory is now on the one side and now on the other, being dependent upon the cold and humid, and the warm and dry, climatic cycles as well as upon the seasons of the year.

When the humid southerly winds extend their influence far into the interior of the continent, and overpower the dry continental winds, the central states and prairie region, the granary of the United States, produce large crops. When the dry winds overpower the humid southerly winds there are droughts and crop failures.

The southerly winds on their way from the Gulf of Mexico do not meet any mechanical obstructions. Since the Appalachian Mountains, running in a northeasterly and southwesterly direction, do not hamper their passage, they are capable of penetrating far into the interior of the country and, therefore, determine the amount of precipitation, even in such states as Minnesota, Nebraska, North and South Dakota. The moisture-laden winds from the gulf, as soon as they reach the land and encounter irregularities, are cooled and begin to lose part of their moisture in the form of precipitation.

As long as the air currents are saturated with moisture the slightest cooling or irregularity of the land that causes them to rise will cause precipitation. But as they move inland and become drier the remaining moisture is given off with difficulty and precipitation decreases. The sooner the humid air currents in their passage over land are drained of their moisture the shorter is the distance from the ocean over which abundant precipitation falls; the longer the moisture is retained in the air currents the farther into the interior will it be carried and the larger will be the area over which precipitation will be distributed.

If precipitation over land depended only on the amount of water directly brought by the prevailing humid winds from the ocean, the land would be pretty arid and rainfall would be confined to only a narrow belt close to the ocean. Fortunately, not all the water that is precipitated is lost from the air currents; a part runs off into the rivers or percolates into the ground, but a large part of it is again evaporated into the atmosphere. The moisture-laden currents, therefore, upon entering land at first lose the moisture which they obtained directly from the ocean, but in their farther movement into the interior they absorb the evaporation from the land. Hence the farther from the ocean the greater is the part of the air moisture contributed by evaporation from the land. At a certain distance from the ocean practically all of the moisture of the air must consist of the

moisture obtained by evaporation from the land. At least it must form a larger part than the water which was obtained directly by evaporation from the oceans.

The vapor brought by the prevailing winds from the ocean is many times turned over or reinvested before it is returned again to the ocean through the rivers.

If we could reduce the surface run-off, and at its expense increase the evaporation from the land, we should thereby increase the moisture of the passing air currents, and in this way contribute to the precipitation of that region into which the prevailing winds blow. This conclusion is almost axiomatic, and there can be no dispute about it.

"CONTINENTAL" AND "OCEAN" VAPOR

For a long time it has been accepted without any question that all the vapor that is condensed in the form of rain or snow over the land surface is furnished by the evaporation of water from the oceans.

The part which vapor from the ocean plays in the precipitation over land has been altogether exaggerated, and it is hardly possible, therefore, to agree with Professor Moore when he says that "the precipitation over the eastern part of the United States is derived entirely from the evaporation from the Gulf of Mexico and the Atlantic Ocean."

A noted European meteorologist, Professor Bruckner, author of a classical work on the climatic fluctuations, has computed the amount of water evaporated from the ocean surface, land surface and the amount of water which is returned to the oceans and the land in the form of precipitation. The balance sheet of the circulation of water on the earth's surface is made up as follows:

CIRCULATION OF WATER ON THE EARTH'S SURFACE
BALANCE SHEET

	Cu. Miles Vapor	Depth Inches	Per Cent.
A. Entire earth surface (196,911,000 miles).			
Evaporation from water surfaces	92,121	29.5	80
Evaporation from land surfaces	+ 23,270	7.5	20
Precipitation on entire earth surface	115,391	37.0	100
B. Oceans (141,312,600 sq. miles).			
Evaporation from oceans	92,121	41.3	100
Amount of ocean vapor carried to the land (net[2])	+ 5,997	2.8	7
	86,124	38.5	93
C. Peripheral land area (44,015,400 sq. miles).			
Ocean vapor (net)	5,997	8.7	29
Continental vapor from the peripheral land surface	— 20,871	29.9	100
Precipitation over the peripheral land area	26,868	38.6	129
D. Closed interior basins with no drainage to the ocean (11,583,000 miles).			
Evaporation from closed basins	2,399	13.0	100
Precipitation over closed basins	2,399	13.0	100

The continental vapor which is fed from the periphery of the land surface is thus about 21,000 cubic miles. It plays, therefore, an important part in supplying the moisture to the air, even a more important part than the vapor directly fed from the ocean. The peripheral regions of the continents, *i. e.*, the regions tributary to oceans, are capable of supplying *seven ninths* of their precipitation by evaporation from their own areas. The moisture which is carried by the winds into the interior of vast continents, thousands of miles from the ocean, is almost exclusively due to continental vapors and not to evaporation from the ocean.

[2] *I. e.*, the difference between the amount of vapor that escapes from land to the ocean and from the ocean to land.

In the interior enclosed basins the precipitation and evaporation, as a rule, are equal to each other.

Bruckner's figures for entire earth's surface are corroborated also by studies of specific drainage areas. The most interesting study in this connection is that by Professors Francis E. Nipher[3] and George A. Lindsay on the rainfall of the state of Missouri and the discharge of the Mississippi River at St. Louis and Carrollton, Louisiana. Nipher found that the average discharge of the Mississippi River at St. Louis during the ten years ending December 31, 1887, was 190,800 cubic feet per second. The amount of water falling per second upon the whole state during the same interval was 195,800 cubic feet per second, or equal within two per cent. to the discharge of the Mississippi River at St. Louis. If, however, a comparison is made between the total rainfall on the basin draining past St. Louis and the river discharge at this point, it appears that the drainage area of the Mississippi and Missouri Rivers above St. Louis is 733,120 square miles, or over 10 times the area of Missouri. These figures show what small portion of the total rainfall over the drainage basin of the Mississippi River is led into the rivers and conducted back to the sea. It is evident that by far the larger portion of the precipitation that falls over the drainage basin is evaporated back from the land into the atmosphere, and is not returned to the sea through the medium of drainage. These figures show further that the source of precipitation of the Mississippi drainage is from evaporation over the land and not derived from evaporation over the sea. Mr. Lindsay[4] computed the discharge of the Mississippi River at Carrollton, Louisiana, and found that the average for fourteen years was 117 cubic miles per year, or 545,800 cubic feet per second, which is less than three times the precipitation over the state of Missouri.

The central portion of the United States is distinctly a continental region, particularly the prairie region, which suffers from lack of precipitation. On the other hand, large areas in the south and southeast suffer from too much humidity because of large swamps, which is caused not only by excessive precipitation, but also by deficient evaporation. Not only the south and southeastern areas suffer from too much water, but also many portions in the north and northeast, where the evaporation is also very slight. We have, therefore, two extremes on the periphery of the United States: (1) In the states adjoining the Atlantic Ocean and the Gulf of Mexico there is an excess of moisture on the ground, both on account of excessive precipitation and slight evaporation; (2) in the vast interior of the central United States, on the other hand, there is a deficiency of moisture, both on account of the scant precipitation and of the intense evaporation. Is there not some connection between these two extremes? Is it not possible that changes which take place in one part of this vast region may exert some influence on the condition of the other? We have seen that in the central states in summer the prevailing westerly and northwesterly winds give way to southerly and southeasterly winds. In other words, in the summer the central states are under the influence of moist

[3] Francis E. Nipher, "Report on Missouri Rainfall, with Averages for Ten Years ending December, 1887," *Transactions of the Academy of Science of St. Louis*, Vol. V., p. 383.

[4] Geo. A. Lindsay, "The Annual Rainfall and Temperature of the United States," *Transactions of the Academy of Science of St. Louis*, June, 1912.

winds, just at the time when the evaporation is the greatest and the forest vegetation is especially active. It seems, therefore, that the amount of moisture evaporated within the more moist region of the United States can influence the conditions of humidity, not only in the States close to the ocean, but also in the region into which the prevailing moist winds flow. The more moisture there is evaporated from the ground in the southern and southeastern portions of the United States, the moister must be the air in the central states and the more precipitation must fall there.

FOREST THE GREATEST EVAPORATOR OF WATER

What are the sources from which the evaporation on land is the greatest? The evaporation from a moist, bare soil is, on the whole, greater than from a water surface, especially during the warm season of the year when the surface of the soil is heated. A soil with a living vegetative cover loses moisture, both through direct evaporation and absorption by its vegetation, much faster than bare, moist soil and still more than free water surface.

The more developed the vegetative cover the faster is moisture extracted from the soil and given off into the air. The forest in this respect is the greatest desiccator of water in the ground.

The latest experiments of Russian agronomists and foresters, corroborated by similar observations in France and Germany, have proved that in level or slightly hilly regions the forest has a desiccating effect upon the ground, causing the water table to be lower under forest than in the adjoining open fields. Professor Henry, in his recent investigations on the effect of forests upon ground waters in level country, has found that the minimum depression of the water table produced by the transpiration of forest trees in the Mondon forest near Luneville, France, amounts to 11.8 inches. With a porosity of the soil strata ranging between 45 and 55 per cent., such depression would correspond to a rainfall of 5.9 inches, which amount to 21,443 cubic feet per acre. This amount of water given off by the forest into the air obviously contributes greatly to the moisture content of the atmosphere above the forest. Dr. Franz R. von Höhnel, of the Austrian forest experiment station at Mariabrunn, carried on observations for a period of three years (1878–1880) upon the amount of water transpired by forests. He found that one acre of oak forest, 115 years old, absorbed in one day from 2,227 to 2,672 gallons of water per acre, which corresponds to a rainfall of from 0.09 to 0.115 inch per day, or 2.9 to 3.9 inches per month. Taking the period of vegetation as five months, the absorption of water would be 158,895 cubic feet, which represents a rainfall for this period of 17.7 inches. This amount of water is given off merely through transpiration from the leaves and does not include the physical evaporation from the surface of twigs, branches, and leaves. These figures, while only approximate, give an idea of the enormous quantities of water given off by forests into the air, which has justly given them the name of the "oceans of the continent."

The most valuable and complete work on the subject is by Otozky, a Russian geologist and soil physicist, which appeared as a publication of the forest experiment stations. Otozky worked up an enormous amount of observations, both his personal and those furnished him by other people, and did not find a single contradictory fact. His conclusion is that the forest, on account of its excessive transpiration, consumes more moisture, all other conditions

being equal, than a similar area bare of vegetation or covered with some herbaceous vegetation. The amount of water consumed by forests is nearly equal to the total annual precipitation; in cold and humid regions it is somewhat below this amount and in warmer and dry regions it is above it.

This enormous amount of moisture given off into the air by the forest, which may be compared to clouds of exhaust steam thrown into the atmosphere, must play an important part in the economy of nature.

If the present area occupied by forests in the Atlantic plain and the Appalachian region were instead occupied by a large body of water, no meteorologist would hesitate for a moment to admit that the water surface has a perceptible influence upon the humidity of the central states and prairie region. Should not, therefore, forests which give off into the atmosphere much larger quantities of moisture than free water surface, have at least a similar influence upon the regions into which the prevailing air currents flow.

If the southern and southeastern winds, in their passage toward the north, northwest and northeast, in the spring and summer, did not encounter the vast forest areas bordering the shores of the Gulf of Mexico and the Atlantic coast and those of the southern Appalachian, and, therefore, were not enriched with enormous quantities of moisture given off by them, the precipitation in the central states and the prairie region would undoubtedly be much smaller than it is now.

What would be the effect of complete or even partial destruction of forests in the Atlantic plain and in the southern Appalachian Mountains upon the humidity of the continental portion of the United States? As the mean temperature in the eastern part of the United States drops rapidly from south to north, the moisture-laden air currents upon entering land would be cooled off and rapidly drained of their moisture within a comparatively short distance from the ocean. The sandy soil which is so characteristic of the southern pine belt of the gulf and south Atlantic States would rapidly absorb the rain which would percolate into the ground, without returning much of it into the atmosphere. The rain falling upon the slopes of the mountains would rapidly run off into streams. While direct evaporation from the ground not sheltered by forest cover may become greater, yet the more rapid run-off and the absence of transpiration by trees would necessarily reduce the total amount of water evaporated into the atmosphere. The land, were it even taken up for agriculture, would not return such large quantities of rain into the atmosphere as the forests did. The inevitable result would be that less moisture would be carried by the prevailing winds into the interior of the country, and therefore less precipitation would occur there. Such is the influence of forests in a level or a hilly country.

Whether forests in the mountains have the same effect as forests in level countries upon the precipitation of the regions into which the prevailing winds that pass over them blow, is difficult to determine. The problem is more complicated for the reason that high mountain chains exert an influence upon the direction of the winds, not only by presenting a mechanical obstruction to the free passage of the air, but also on account of the difference in the heating of the different slopes. A moist current of air in passing over a mountain chain undergoes several changes. It is known that the air in ascending becomes cooler. The temperature of not fully saturated air decreases 1° F. for every 182

feet of ascension. In ascending the mountain slope the water-holding capacity of the air decreases until the saturation point is reached, and fogs, clouds and precipitation begin to form. The further cooling of the air is counteracted to some extent by the heat that is given off in the process of the condensation of vapor. This further cooling, therefore, proceeds only at the rate of about 0.5° F. for every 182 feet of ascension, or only half as much as when the air is dry. After the air current has passed the crest of the mountain and lost an amount of moisture corresponding to the temperature which it had at the time of passage, it descends on the leeward side and becomes heated.

In its descent it absorbs the fogs and clouds. In this process it consumes some heat. The further heating goes on at the rate of 1° F. for every 182 feet of descent. The more moisture there is extracted on the windward side of the slope, the greater is the temperature of the air on the leeward side.

If, for instance, an air current before ascending had a temperature of 50° F. at a barometric pressure of 30 inches, and the crest over which it passed was 9,900 feet high, then, on the leeward side at the same altitude at which it began to ascend, it would not have a temperature of 50° F., but of 77° F. at a relative humidity of 21 per cent. At other ascensions by the same current of air, the same changes would take place. But new precipitation, as a rule, begins on the next chain of mountains only at an altitude equal to that of the crest of the previous mountain chain over which the current of air has passed.

Professor Mayr[5] has shown that wherever there are several parallel chains of mountains perpendicular to the moist-air current, such as are found on the Pacific coast, of which each one is higher than the previous one, the forest appears in each consecutive mountain chain only from an altitude equal to the altitude of the top of the preceding chain over which the air current has passed. Between the mountain chains there remain treeless, dry valleys. This is strikingly observed in the Pacific coast and Rocky Mountains, as well as in Caucasus and Turkestan.

[5] "Waldungen von Nord Amerika."

As a rule, the moist air currents, in passing over wooded slopes, being chilled, deposit most of their precipitation on the windward side. It is only in exceptional cases, such as when the air that passes over the wooded slopes is not fully saturated, or when warm currents rise from below, that the air current, instead of depositing moisture, becomes enriched with moisture and carries it over the crest to the regions lying farther on its way.

This may occur on southern slopes, which are apt to become warm. The influence of wooded windward slopes upon the humidity of the regions lying to the leeward side of the mountain chains, therefore, varies. It is apparent, however, that, while the forests in the mountains at right angles to prevailing moist winds have a marked influence upon local precipitation, their influence upon the humidity of regions lying to the leeward of them can not, on the whole, be very great.

CONCLUSIONS

If the effect of mountainous forests upon the precipitation of regions lying in the lee of them is not entirely clear to us, the effect of forests in wide plains of continents, especially in the path of moist winds, can not be doubted. By increasing the evaporation from the land at the expense of surface run-off they enrich with moisture the passing air currents, and in this way help to carry it in larger quantities

into the interior of continents. The destruction of such forests, especially if it leaves the ground bare or partly covered with only weak vegetation which does not transpire large quantities of water, must inevitably affect the climate, not so much the climate of the region in which the destruction took place but the drier regions into which the prevailing air currents flow.

I realize, of course, that direct proof of this climatic influence quantitatively expressed is still lacking. It will take many decades before direct observations of such a character will be secured. If, however, the premises upon which the discussion rests, namely, that the precipitation of the eastern half of the United States is intimately connected with the prevailing south winds, that evaporation from land contributes more to the precipitation over land than evaporation from the ocean, that forests evaporate more water than free water surface, or any other vegetation, then forests in the path of prevailing winds must necessarily act as distributors of precipitation over wide continents.

What practical deductions can be made from these facts?

1. Forests must be protected not so much in localities which already suffer from lack of moisture as in regions which lie in the path of prevailing winds and are still abundantly supplied both with ground water and precipitation. In the dry regions large bodies of forests may have the opposite effect upon the available water supply. There only forests growing along rivers may contribute to the humidity of the region. There rows of trees or windbreaks surrounding fields and orchards, by preventing the drifting of the snow and decreasing the activity of the wind, will act more as conservers of moisture in the soil than solid bodies of timber. Therefore, the care with which forests should be protected in the eastern half of the United States must increase from north to south and from west to east.

2. In the Atlantic plain and southern Appalachians, which are the gateway for the prevailing winds from the Gulf of Mexico and the Atlantic Ocean, forests must be especially maintained.

(*a*) On moist soils, provided the excess of water or the substances contained in it do not prevent their development, because the moister the soil on which forests grow the more moisture they evaporate. For this reason swamps, since they contribute less to the moisture contents of the air than crops or forests and lose considerable water by surface run-off, must be drained, as by doing this an increase of the evaporation at the expense of surface run-off may be secured.

(*b*) On sandy soils. Forests on sandy soils readily absorb water through the roots and evaporate it into the atmosphere. Denuded of forest cover, sandy soils readily absorb rainwater which percolates into the ground and often reaches the sea by underground channels without being returned to the atmosphere.

(*c*) On steep slopes and rocky places; the removal of forests on such places inevitably leads to an increase in the surface run-off and to a corresponding decrease in local evaporation.

3. If clearing of the forest is a necessity it should be done only under condition that the cleared land is to be devoted to intense cultivation, as, after forests, crops contribute most to the moisture of the air. The highest organic production, therefore, is in harmony with the safeguarding of the humidity in the regions which lie in the path of the prevailing winds. Cleared land that becomes waste or poor pastures or grows up to weak vegetation, means so much evaporation lost to the passing air currents.

The effect of forests upon climate, if viewed as a local influence, must necessarily be insignificant. First we must not forget that whenever we compare a forest with an open field adjoining it, the open field itself is under the influence of the forest and can not give a proper conception of the true effect of the forest.

Such a meteorological authority as Lorenz Liburnau, at the end of his monumental work on "The Results of Forest Meteorological Observations," remarks that his data and conclusions apply only to the influence which the forest exerts while it exists, but do not extend to conditions which may rise upon its complete destruction. "If, for instance, according to our observations in the Carpathian foothills, it appears that the influence of the forest upon the neighboring country is only insignificant, this does not indicate that a complete destruction of all the existing forests will produce here also only insignificant climatic changes. Very likely that, if the forest were completely destroyed, the difference would be much greater than the difference that exists now between the climate of the forest and its neighboring areas."

Local observations, no matter how accurately and minutely carried out, can not lead us to the solution of the problem. The method of attack itself is wrong. It is only by approaching the problem from a much broader standpoint, by rising mentally to a height which opens wide perspectives both to the distant shores of the Gulf of Mexico and the Atlantic Ocean and to the most interior portions of the continent; only by following the moist south winds on their way from the gulf through the gateway of the North American continent, the Atlantic plain to the Prairie region, by considering how many times the moisture carried by the wind is dropped in the form of precipitation and raised again as evaporation, by studying the part which the vegetative cover plays in this circulation of water on the land, especially the dense coniferous forests, that we can grasp the problem in its true light.

RAPHAEL ZON

U. S. FOREST SERVICE

LESTER FRANK WARD

LESTER FRANK WARD, A.B., LL.B., A.M., LL.D., was born at Joliet, Illinois, June 18, 1841, and died in Washington, D. C., April 18, 1913.

Philosopher, sociologist, paleobotanist—few men in these days of specialization have earned such enviable reputation along such widely divergent lines of thought as are designated in these terms, which imply both a deep thinker on abstract subjects and a careful student of concrete facts. The scope of his mentality was remarkable, not alone in the ability to master any subject in which he chanced to become interested, but also in the ability to completely dismiss any subject from his mind whenever he wished to concentrate attention on something entirely different, and to subsequently resume the original trend of thought without apparent effort.

His reputation as a student of and writer on ethical and sociological subjects assures that he will not be forgotten or fail of suitable recognition by those who are best qualified to discuss his activities in such connection. It is my privilege to merely say a few words in regard to Dr. Ward as a paleobotanist.

Our personal acquaintance began in 1882, about a year after his appointment as assistant geologist on the staff of the United States Geological Survey. His special work was in connection with the problems of paleobotany and their relations to geological investigations, the importance of which was just beginning to attract some attention, and it was my good fortune to enlist his interest and to subsequently enjoy the privilege of his cooperation and kindly criticism in my paleobotanical studies and to feel the inspiration of his con-

scientious and careful methods of procedure, for a period of almost thirty years.

Dr. Ward possessed a good working knowledge of botany and geology at the time when he entered upon his duties in the Survey, and it is interesting to note that one of the earliest of his published works was a "Guide to the Flora of Washington and Vicinity"—the fruit of his many local tramps and explorations from which he derived the keenest pleasure. Several short articles, published in the *American Naturalist* and elsewhere, had preceded this, two of which "On the Natural Succession of the Dicotyledons" and "Homologies in the Lauraceæ," may be cited as foreshadowing the philosophical and evolutionary tendency of the works that were to follow. The drift into paleobotany was almost inevitable, even had it not been included in the line of official duties. Among the titles of papers which appeared in rapid succession, for example, were such as "Evolution in the Vegetable Kingdom," "The Ginkgo Tree," "The Paleontologic History of the Genus *Platanus*," "Historical View of the Fossil Flora of the Globe," "Geological View of the Fossil Flora of the Globe," "Botanical View of the Fossil Flora of the Globe," "Sketch of Paleobotany," "Geographical Distribution of Fossil Plants," etc. The two last mentioned are exhaustive dissertations which are standard works of reference for all who are interested in the bibliography and general principles of the subject and the recorded localities in which fossil plants have been found in the different parts of the world. These two works, issued in 1885 and 1888, respectively, demonstrate in a striking manner the wide acquaintance with paleobotanical literature which he had already acquired, and the wealth of such material which he had so rapidly gathered together. The pioneers of the science in America—Dawson, Newberry and Lesquereux—had blazed the way; but it remained for Dr. Ward to realize the necessity for systematic preparation in order to insure accuracy and to place the science on a firm and dignified footing which would win for it the recognition that it deserved. With his tireless energy and persistence he gradually gathered together, largely through personal correspondence and exchange, all obtainable works directly or indirectly treating of fossil plants, and thus built up a library which, with recent additions, is to-day, without doubt, the most complete of its kind in the world.

He also foresaw the necessity of having at hand, for ready and accurate reference, an index of the genera and species of fossil plants and their places of publication. He fully realized the years of hard work, both mental and mechanical, which the undertaking involved, with but little to show as an ultimate result which would be appreciated or even understood by any except the limited number of persons actively interested in paleobotanical investigations. Nevertheless it was undertaken and has been successfully continued and elaborated and brought up to date; and it is no exaggeration to say that the accuracy and completeness which characterize the paleobotanical publications of the Survey are in large measure due to this work, conceived and begun by Dr. Ward. It includes some 80,000 references to descriptions and illustrations of fossil plants, and a bibliography of about 12,000 titles by about 2,000 authors. Dr. Ward's titles alone, including reviews, number about one hundred and fifty. Critical paleobotanical work in America can not be prosecuted without its aid, and all American students and writers on the subject must, at times, consult it and the library connected with it, in order to obtain information nowhere else available.

The relations of fossil plants to geology, and their value and importance in stratigraphic investigations, were discussed and indicated in many of Dr. Ward's more extended works, such as "Synopsis of the Flora of the Laramie Group," "Evidence of the Fossil Plants as to the Age of the Potomac Formation," "The Plant-bearing Deposits of the American Trias," "Principles and Methods of Geologic Correlation by Means of Fossil Plants," "Status of the Mesozoic Floras of the United States," etc. He also contributed the article on Fossil Plants for Johnson's Encyclopedia

in 1895, and the botanical and paleobotanical definitions for the Century Dictionary.

Dr. Ward had a wonderful faculty for coordinating and systematizing facts and information. The former were always clearly stated and presented in logical sequence, and the arrangement of his text was always carefully thought out. His guiding principle in all his writings was that he was not writing for himself, but for others, and he always tried to place himself in the position of those who would have occasion to read or consult or cite what he had written. The consequence is his works may be easily read, or quickly referred to, or accurately cited in any particular.

His influence and example as a systematic, orderly, and conscientious worker and writer have left an indelible impression upon all who were associated with him and will be felt, consciously or unconsciously, by all who may follow in his footsteps.

ARTHUR HOLLICK

NEW YORK BOTANICAL GARDEN,
June 30, 1913

GERMAN AND SWISS UNIVERSITY STATISTICS

THE preliminary statistics of the number of students enrolled in German universities during the winter semester of 1912–1913 (Deutscher Universitätskalender, 83. ed.) show that the total number of matriculated students amounted to 58,844 as against 58,672 in the summer semester of 1912. Including auditors the totals are 64,590 and 63,351, respectively. Of the auditors registered in the winter semester 3,997 were men and 1,749 were women, while of the matriculated students, no less than 3.213 were women, these being distributed by faculties as follows:

Theology	11
Law	79
Medicine	715
Philosophy	2,408

The following universities attracted the largest number of women students:

Berlin	904
Bonn	289
München	262
Göttingen	237
Heidelberg	219
Freiburg	189
Münster	172
Breslau	150
Leipzig	129
Marburg	126

It may be interesting in this connection to call attention to some statistics recently published by the French Ministry of Education, showing that the percentage of women students in France in 1912 was 9.8 per cent. as against 4.8 per cent. in Germany.

Excluding the emeritus professors, the faculties of the German universities in the summer semester of 1913 are manned by 1,306 full professors, 131 honorary full professors, 788 adjunct professors, 3 honorary adjunct professors and 1,210 docents.

The matriculated male students enrolled in the winter semester were distributed by faculties as follows:

Protestant theology	3,386
Catholic theology	1,785
Law	11,376
Medicine, pharmacy and dentistry	15,309
Philosophy	26,988

The largest number of matriculated students, namely, 9,806, was enrolled at the University of Berlin, this institution being followed by the remaining 20 institutions in the following order:

München	6,759
Leipzig	5,351
Bonn	4,179
Halle	2,906
Breslau	2,710
Göttingen	2,660
Freiburg	2,627
Heidelberg	2,264
Münster	2,154
Marburg	2,076
Strassburg	2,063
Tübingen	1,898
Jena	1,842
Kiel	1,738
Königsberg	1,616
Würzburg	1,455
Giessen	1,338

Erlangen	1,261
Greifswald	1,260
Rostock	881

The largest faculties of Protestant theology range in the following order:

Berlin	555
Leipzig	466
Halle	401
Tübingen	336

For the largest Catholic schools of divinity the order is as follows:

Bonn	400
Münster	305
Breslau	269
Freiburg	225

The University of Berlin possesses the largest schools of law (2,280) and philosophy (4,732), being followed in law by München (1,165), Leipzig (892), Bonn (846), Breslau (535) and Freiburg (519); in philosophy by Leipzig (2,832), München (2,347), Bonn (2,156), Göttingen (1,740) and Halle (1,642).

The University of München leads in medicine with 2,287 matriculated students, to which must be added 203 in pharmacy and 94 in dentistry; Berlin follows with 2,239 students; then come Freiburg with 1,029 students (plus 35 pharmacists), Leipzig with 947 (plus 136 pharmacists and 78 dentists), Heidelberg with 734, Bonn with 652, Breslau with 641, and Würzburg with 615 (plus 76 dentists and 47 pharmacists).

The largest enrollment of foreigners during the winter semester of 1912–13 was found at the University of Berlin, where 1,605 matriculated foreigners were enrolled. Berlin was followed by

Leipzig	784
München	687
Halle	315
Heidelberg	264
Königsberg	244
Strassburg	191
Freiburg	177
Göttingen	174
Breslau	162
Bonn	144
Jena	140

Altogether there were 5,193 matriculated foreigners enrolled at the German universities; of these 4,648 hailed from Europe, 338 from America, 184 from Asia, 22 from Africa and 1 from Australia. Of the Americans 171 studied at Berlin, 36 at München, 31 at Göttingen, 21 at Heidelberg and 20 at Leipzig. Of the European countries, Russia had the largest number of representatives, namely, 2,840, of whom 641 were enrolled at Berlin, Russia being followed by

Austria	900
Switzerland	340
Roumania	156
Great Britain	145
Bulgaria	111
Greece	100
Turkey	78
Servia	61
Luxembourg	58
France	53
Holland	47
Italy	39
Sweden	27
Spain	25
Norway	20
Belgium	19
Denmark	13
Portugal	10
Montenegro	1

The number of students matriculated at the seven Swiss universities in the winter semester of 1912–13 amounted to 7,019 as against 7,226 in the summer semester of 1912. 53.33 per cent. of these students hailed from Switzerland, 30 per cent. from Russia and the Balkan States, 10 per cent. from Germany and Austria, 2.5 per cent. from France and Italy, and 4.4 per cent. from other countries. No country in the world has as large a percentage of foreign students at its institutions of higher learning as Switzerland has.

Rudolf Tombo, Jr.
Columbia University

CONTRIBUTIONS TO GENERAL GEOLOGY

Of late years survey authors have become contributors to scientific and technical journals to an extent that suggests the need of an official channel for papers of a certain type.

Participation in contributions to these outside journals is a valuable phase of the survey's activity and should continue, but this method of publication has certain limitations by reason of both the capacity and the circulation of these journals. It appears, therefore, that the time has come to begin the issue of an annual volume in the survey series that will afford opportunity for publication of short papers and preliminary reports of a character not well adapted to any of the present forms of publication.

It is significant that so many of the geologists are making scientific contributions of general interest that represent results incidental to other investigations or that are of the nature of by-products in strictly economic work. In order to develop greater breadth of observation and investigation among the geologists of the survey and to promote the scientific possibilities of their professional work means should be provided for prompt publication of such papers in a permanent form that will commend itself to the author and to the scientific reader alike. Provision has been made since 1902 for the current publication of short papers relating to economic geology, and the time is opportune for a similar provision for scientific papers relating to general geology.

It is proposed to issue an annual volume in the Professional Paper series, entitled "Contributions to General Geology" (short papers and preliminary reports).

In advance of the printing of the full volume, separates, each including one or more papers, will be issued to the number of ten or twelve a year as the manuscript and illustrations are ready, without waiting for material for the full volume to be in hand or even promised. The papers included in these "Contributions to General Geology" may relate to any phase of geology, provided it possesses general interest—petrology, paleontology, stratigraphy, glaciology, structural geology, etc. This volume is intended not as a catch-all for current odds and ends, but as a dignified collection of scientific contributions, each worthy in importance of subject, value of results and quality of treatment for separate publication as a bulletin or professional paper if it were of sufficient length. Two papers before me which will probably be included in the first separate of the 1913 "Contributions" are Mr. Shaw's "Mud Lumps at the Mouths of the Mississippi" and Mr. Gale's "Origin of Colemanite Deposits." Illustrations in this publication, as in the "Contributions to Economic Geology," should be few in number and confined to line cuts and halftones, for prompt publication is essential. The date of actual publication will be printed on the title-page of each separate.

The chief geologist will begin to receive manuscripts at once, in the hope that several separates may be issued between July and December, and that the 1913 volume may be published early in January, when the first separate for 1914 will also be expected.

Geo. Otis Smith,
Director

MEDICAL RESEARCH IN GREAT BRITAIN[1]

Mr. Lloyd George, as minister responsible to parliament for National Health Insurance, has appointed the following persons as a committee with executive functions, to be known as the Medical Research Committee, for the purpose of dealing with the money made available for research under the National Insurance Act:

The Right Hon. Lord Moulton of Bank, LL.D., F.R.S. (chairman).

Christopher Addison, M.D., F.R.C.S., M.P.

Waldorf Astor, M.P.

Sir T. Clifford Allbutt, K.C.B., M.D., F.R.C.P., F.R.S., regius professor of physic, University of Cambridge.

Charles John Bond, F.R.C.S., senior honorary surgeon, Leicester Infirmary.

William Bulloch, M.D., F.R.S., bacteriologist to the London Hospital and professor of bacteriology in the University of London.

Matthew Hay, M.D., LL.D., professor of forensic medicine and public health, Aberdeen University.

Frederick Gowland Hopkins, M.B., D.Sc., F.R.S., reader in chemical physiology in the University of Cambridge.

[1] From the London *Times*.

Brevet Colonel Sir William Boog Leishman, M.B., F.R.S., professor of pathology, Royal Army Medical College.

These first appointments are for three years in each case; in and after 1916 three members, to be selected in manner to be prescribed, shall retire at intervals of two years, their places being filled (whether by reappointment or otherwise) by the minister responsible for National Health Insurance.

The duties of the committee will be to formulate the general plan of research and inquiry at the outset and for each year, to make arrangements for carrying it out, and to supervise its conduct so far as may be necessary, and in particular to secure adequate coordination of the various parts of the scheme. The committee will also deal with the collection and publication of information, and of the results of statistical and other inquiries so far as suitable or necessary. For this purpose it will determine, subject to the assent of the minister responsible for National Health Insurance, the expenditure of the money available each year, the total of the sums available under paragraph (*b*) of subsection (2) of section 16 of the Act being about £57,000 per annum. Before the minister responsible for National Health Insurance gives his final assent to the Medical Research Committee's scheme for any year, he will receive criticisms and suggestions in regard to it from the Advisory Council for Medical Research.

This Advisory Council has been appointed for the purpose by Mr. Lloyd George, as minister responsible for National Health Insurance, after receiving suggestions for suitable names from each of the universities of the United Kingdom, from the Royal Colleges of Physicians and of Surgeons, from the Royal Society, and from other important public bodies interested in the question. It includes medical representatives of the four National Health Insurance Commissions, and the other principal government departments concerned in medical work. The first appointments are for three years in each case; in and after 1916 one third of the members, to be selected in manner to be prescribed, shall retire at intervals of two years, their places being filled (whether by reappointment or otherwise) by the minister responsible for National Health Insurance.

The duty of the Advisory Council will be to consider the scheme of the Medical Research Committee, when referred to them, as above explained, and to afford to the minister all such criticisms and suggestions in regard to it as they may think desirable to submit to him from the point of view of securing that adequate consideration is given to the different problems arising and the various kinds of research work going on in the different parts of the United Kingdom and in other portions of the empire, in America, and in foreign countries, and also to the general scope of the research work to be undertaken under the committee's scheme.

The membership of the Advisory Council for Medical Research is as follows:

The Right Hon. Lord Moulton of Bank, LL.D., F.R.S. (chairman), Miss L. B. Aldrich-Blake, M.D., M.S., Sir W. Watson Cheyne, Bt., C.B., F.R.C.S., F.R.S., Sir William S. Church, Bt., K.C.B., M.D., Sidney Coupland, M.D., David Davies, M.P., Sheridan Delépine, M.B., Sir James Kingston Fowler, K.C.V.O., M.D., Sir Rickman J. Godlee, Bt., F.R.C.S., Sir Alfred Pearce Gould, K.C.V.O., F.R.C.S., David Hepburn, M.D., Arthur Latham, M.D., Sir John McFadyean, M.B., W. Leslie Mackenzie, M.D., J. C. McVail, M.D., W. J. Maguire, M.D., S. H. C. Martin, M.D., F.R.S., Robert Muir, M.D., Alexander Napier, M.D., Sir George Newman, M.D., Arthur Newsholme, C.B., M.D., J. M. O'Connor, M.B., Sir William Osler, Bt., M.D., F.R.S., A. C. O'Sullivan, M.B., Marcus S. Paterson, M.D., Sir Robert W. Philip, M.D., Sir William H. Power, K.C.B., F.R.C.S., F.R.S., H. Meredith Richards, M.D., Lauriston E. Shaw, M.D., Albert Smith, M.P., J. Lorrain Smith, M.D., F.R.S., T. J. Stafford, C.B., F.R.C.S.I., T. H. C. Stevenson, M.D., Harold J. Stiles, F.R.C.S., Edin., Sir Stewart Stockman, M.R.C.V.S., W. St. Clair Symmers, M.B., Miss Jane Walker, M.D., Norman Walker, M.D., J. Smith Whitaker, M.R.C.S., L.R.C.P., Sir Arthur Whitelegge, K.C.B., M.D., G. Sims Woodhead, M.D.

THE EDUCATIONAL FUND COMMISSION OF PITTSBURGH

THE Educational Fund Commission of Pittsburgh, to which was intrusted one quarter of a million dollars some five years ago, for the betterment of teachers and teaching in the public schools, has now made the awards for this year, making a total of about four hundred and seventy-five that this commission has sent out for study during the past four years. The chairman of the commission, Dr. John A. Brashear, writes:

I think I can readily say that ninety-five per cent. of these teachers have brought back value received to our public schools in the way of efficiency. We do not ask these teachers to work hard, preferring that they take a very small number of studies and enjoy a part of their time in rest, recreation and recuperation. Nor do we lay great stress on the purely intellectual side of their work, preferring that they bring back to us efficiency in the way of improving home life, social, moral and physical betterment. This they have not only done in the past, but through the splendid influence of their associations have distributed the good they have received in their summer studies among their fellow teachers in our great school system.

I am also pleased to report that the deans of the various summer schools have received our Pittsburgh teachers with very great kindness, indeed, to such an extent that perhaps fifty per cent. of them return the following year to study upon their own initiative and pay their own summer tuition and expenses.

I wish I could give you the name of the donor, but notwithstanding the great work done for the public schools of Pittsburgh, he insists that his name remain anonymous.

The summer schools for which scholarships were given, and number of teachers to be sent to each school by the Educational Fund Commission is as follows:

Harvard University	16
Columbia University	15
Chautauqua	14
University of Pittsburgh	16
Carnegie Institute of Technology	13
University of Wisconsin	11
Cornell University	14
University of Michigan	7
University of Chicago	4
University of Colorado	2
University of Pennsylvania	3
Cape May School	5
Pennsylvania State College	5
Dartmouth	3
Zanerian College	3
Syracuse University	2
Northwestern University	1
New York University	1
Johns Hopkins University	1
Boothbay Harbor	1
Art Institute, Chicago	1
Vineland Training School	1
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THE ROCHESTER MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE forty-eighth annual meeting of the American Chemical Society will be held in Rochester, New York, September 9 to 13, inclusive. A meeting of the council will be held on Monday night, September 8, at the Hotel Seneca, immediately following the complimentary dinner to be given to the council at seven o'clock.

The program will open with a general meeting on Tuesday at 10 A.M., in the assembly hall at Kodak Park. The members of the society are to be the guests of the Eastman Kodak Company at luncheon following the morning meeting, and the afternoon will be spent in visiting the immense plant of the Eastman Kodak Company at Kodak Park.

A smoker will be held at 8:30 P.M., Tuesday, in Masonic Hall. The divisional meetings on Wednesday, all day, and Thursday and Friday mornings, will be held in the Eastman building, University of Rochester. The president's address will be given at the East High School, Rochester, at 8 P.M., Wednesday; and the subscription banquet, Thursday night at 7 P.M., at Powers Hotel.

On Thursday and Friday afternoons, excursions will be open to the following manufacturing plants:

Bausch and Lomb Optical Co.,
Taylor Instrument Co.,
Curtice Bros. Co.
J. Hungerford Smith Co.,

Moerlback Brewery,
German-American Button Co.,
Genessee Reduction Co.,
Municipal Incinerator,
Stecker Lithographic Co.,
and possibly others.

The following are the addresses of the divisional and sectional secretaries:

Industrial Division—S. H. Salisbury, Jr., Lehigh University, South Bethlehem, Pa.

Physical and Inorganic—R. C. Wells, U. S. Geological Survey, Washington, D. C.

Fertilizer—J. E. Breckenridge, Carteret, N. J.

Agricultural and Food—G. F. Mason, care of Heinz Company, Pittsburgh, Pa.

Organic—Wm. J. Hale, University of Michigan, Ann Arbor, Mich.

Pharmaceutical—Frank R. Eldred, 3325 Kenwood Ave., Indianapolis, Ind.

Rubber—Dorris Whipple, care of The Safety Insulated Wire and Cable Co., Bayonne, N. J.

Biological—I. K. Phelps, Bureau of Mines, 40th and Butler Sts., Pittsburgh, Pa.

SCIENTIFIC NOTES AND NEWS

DR. JOSEPH SWAIN, president of Swarthmore College, was elected president of the National Educational Association at its recent Salt Lake City meeting. Dr. Robert J. Aley, president of the University of Maine, was elected president of the National Council of Education.

THE fourteenth series of the Lane medical lectures will be given by Professor Sir Edward Schäfer, professor of physiology, University of Edinburgh. These lectures will be upon "The Functions of the Ductless Glands especially in relation to other Secreting Organs." They will be delivered on the evenings of September 3, 4, 5, 8 and 9, in the Lane Hall of the Stanford University Medical Department, San Francisco.

THE Berlin Academy of Science has awarded its gold Leibnitz medal to Professor Georg Schweinfurth for his explorations and researches in Africa.

PROFESSOR RUDOLF STURM, the distinguished mathematician of the University of Breslau, has celebrated the fiftieth anniversary of his doctorate.

MR. WILLIAM STANLEY, of Great Barrington, Mass., electrical inventor and engineer, has received the Edison gold medal awarded by the American Institute of Electrical Engineers for meritorious achievement in electricity.

THE Michigan Agricultural College has conferred the degree of doctor of science upon Mr. William A. Taylor, chief of the bureau of Plant Industry, United States Department of Agriculture.

DR. ERWIN F. SMITH, plant pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, has been awarded a certificate of merit by the American Medical Association. This was consequent upon an exhibit made by Dr. Smith at the recent annual meeting of association at Minneapolis illustrative of the results of his researches upon cancer in plants. On June 28 Dr. Smith delivered an address upon this subject at the University of Wisconsin under the auspices of the Department of Plant Pathology.

DEAN W. F. M. GOSS, of the engineering college, University of Illinois, has been granted leave of absence for one year beginning July 1, 1913, to enable him to serve as chief engineer to the Chicago Association of Commerce committee on the investigation of smoke abatement and the electrification of railway terminals.

DR. J. S. FLETT, F.R.S., assistant director, Geological Survey of Great Britain; Dr. A. Lacroix, professor of mineralogy, Natural History Museum, Paris, and Professor E. Weinschenk, Munich, have been elected life honorary members of the Geological Society of South Africa.

THE alumni of Adelbert College, Western Reserve University, at the last commencement adopted the following resolution:

WHEREAS: Charles J. Smith has continuously filled the chair of mathematics in this college for a period of forty-three years and is about to relinquish the duties of an active professor, and

WHEREAS: The alumni thereof duly appreciate his long and honorable career as such professor and the personal benefits they have derived from his instruction,

Resolved, That we, the alumni of Adelbert College of Western Reserve University, express our deep appreciation of his scholarly attainments, the benefits we have derived from his instruction and our affectionate regard for him as a man, our hope that he may be spared for many years to enjoy the fruits of his life's work, and that the secretary of this alumni association be instructed to place in Professor Smith's hands a copy of this resolution.

DR. M. W. TWITCHELL, formerly professor of geology at the University of South Carolina and now assistant state geologist of New Jersey, has returned from two months' leave of absence, during which he served as acting professor of geology at the University of Colorado, while Professor R. D. George was engaged upon other duties as state geologist of Colorado.

PROFESSOR H. A. GLEASON, assistant professor of botany, University of Michigan, will leave in September for a year's travel, during which he will visit Australia, the Philippines, Java and Ceylon.

PROFESSOR H. E. GREGORY, of Yale University, has been studying the geology and water resources of the Navajo Reservation, in parts of New Mexico, Arizona and Utah, under the auspices of the U. S. Geological Survey.

IT is proposed to commemorate in 1914 the seventh centenary of Roger Bacon's birth by erecting a statue in his honor in the Natural History Museum at Oxford, and by raising a fund for the publication of his works.

DR. HORACE JAYNE, formerly professor of vertebrate morphology in the University of Pennsylvania, dean of the college and of the faculty of philosophy, and director of the Wistar Institute, died on July 8, aged fifty-four years.

DR. PHILIP LUTLEY SCLATER, from 1859 to 1902 secretary to the Zoological Society of London, distinguished for his work on the systematic zoology of birds and mammals and on geographic distribution, died on June 27, aged eighty-four years.

NEW YORK state civil service examinations will be held on July 26, as follows: In the State Department of Highways—for division engineer at a salary of $4,000 a year; for superintendents of construction and maintenance at salaries of from $2,500 to $3,000; for chiefs of construction and maintenance at salaries of $4,000 a year. In the office of the state architect—for heating engineer at a salary of $1,500 to $2,500 a year; for sanitary engineer at a salary of $2,000 to $2,500, and for electrical draftsman at a salary of $1,500 to $1,800. Examinations will also be held for the position of bridge designer at a salary of $1,500 to $2,100 and of junior bridge draftsman at a salary of $900 to $1,200. Application blanks can be obtained from the office of the commission at Albany until July 16.

MRS. A. H. CLARKE, of Earl's Court, has given to the University of London the collection of continental and exotic macrolepidoptera made by her late husband, who was one of the senior fellows of the Entomological Society. The section of exotic butterflies consists of nearly 6,000 specimens from all parts of the world, and is particularly valuable as a reference collection, not merely from the number and careful selection of the forms represented (some being of great rarity), but from the perfect condition and beauty of the specimens themselves. The whole donation comprises over 12,000 specimens all carefully set, arranged and labeled; and to it Mrs. Clarke has added her husband's working library of entomological literature. After the work of arranging and cataloguing has been concluded, the collections will be available for reference by entomologists generally upon application to the professor of zoology at the university.

THE Board of Agriculture of Ceylon has appointed a committee in London to arouse public interest in the establishment of an Imperial Central College of Tropical Agriculture in the far east. At the annual meeting of the Ceylon Association, held on June 12 in the Chamber of Commerce, London, it was unanimously resolved that the association approved

of Peradeniya, Kandy, as the best site for the proposed college. It was stated that the Peradeniya Gardens are uniquely situated for the purpose. The local climate is excellent. In every direction are vast plantations of all kinds of tropical products, which afford splendid opportunities for studying estate work on the spot. The whole of Ceylon, in fact, is devoted to every variety of tropical agriculture. Another great local advantage is that the student would find himself in continual contact with the Tamil—the Indian agricultural laborer of the east and of most tropical colonies.

THE London *Times* states that the *Terra Nova,* which arrived at Cardiff on June 14, carried the natural history collections of the Scott Antarctic Expedition which fill nearly 200 cases. These have been transferred to the Natural History Museum at South Kensington. The collections are of high scientific interest. Perhaps the most important, and from the personal point of view certainly the most precious, is the collection of fossils discovered by Captain Scott and Dr. Wilson during their ill-fated return journey from the South Pole. This box of fossils was found on a sledge when the relief party arrived at the place where Captain Scott and his brave companions perished. The whereabouts of the sledge was indicated by a pole which Captain Scott had erected, knowing that the sledge would be hidden by snow. The box is at present intact. The other collections comprise birds (including many penguins), seals and whales. There is a very large and extensive collection of marine specimens—crustaceans, molluscs, echinoderms, etc. The botanical specimens are numerous, and there are many mosses and lichens. The collection as a whole is very much larger than that which was brought home by the *Discovery.* It bears testimony to the care with which Captain Scott organized his expedition, and to the thoroughness with which his plans for its scientific work have been carried out. The results, when fully described, can not fail to add largely to our knowledge of the natural history and the past climatic conditions of the Antarctic regions.

THE eighty-first annual meeting of the British Medical Association will be held at Brighton on July 22, 23, 24 and 25, under the presidency of Dr. William Ainslie Hollis. Sixteen scientific sections have been arranged and will meet daily, namely, Bacteriology and Pathology; Climatology and Balneology; Dermatology; Diseases of Children, including Orthopædics; Electro-therapeutics; Gynæcology and Obstetrics; Laryngology, Rhinology and Otology; Medical Sociology; Medicine; Navy and Army and Ambulance; Neurology and Psychological Medicine; Ophthalmology; Pharmacology, Therapeutics and Dietetics; State Medicine; Surgery, and Tropical Medicine. On July 23, Professor George R. Murray will deliver an address on medicine; on July 24, the address on surgery will be delivered by Sir Berkeley Moynihan, and on July 25, a popular lecture with cinematograph illustrations, entitled "Some Wonders of Animal and Plant Life in Pond and Pool," will be delivered by Mr. Edmund Johnson Spitta.

THE Australian Institute of Tropical Medicine at Townsville, which was founded as the result of an amalgamation of the schemes of Professor Anderson Stuart, of Sydney, and of the ex-Bishop of North Queensland, and now mainly supported by the commonwealth, was opened on June 28 by Sir William Macgregor. The Australian Universities, in conjunction with the institute, grant a diploma in tropical medicine.

AT the last session of the legislature of Maine a continuous annual appropriation of $5,000 was made to the Maine Agricultural Experiment Station for "investigations in animal husbandry." The event is chiefly notable because of the fact that this is the first money ever appropriated by the state to the experiment station for the direct support of work of investigation. Hitherto all support of research has come from federal (Hatch and Adams) funds. The added funds were specifically appropriated and will be used for the extension of the investigations in the field of genetics,

carried on by the department of biology in charge of Dr. Raymond Pearl. The department has been accorded additional laboratory space in the station building. The staff has been increased by the appointment of Dr. Frank M. Surface, formerly biologist of the Kentucky Agricultural Experiment Station, as biologist; and of Mr. John Miner, a graduate of the University of Michigan, where he specialized in the study of actuarial and statistical mathematics under the direction of Professor James W. Glover, as computer.

ON Friday, June 27, the new wing of the Rothamsted laboratories was opened. According to the account in *Nature* Mr. Runciman, president of the British Board of Agriculture, sketched the history of the Rothamsted Experiment Station from its beginning in 1843 to the present time. The experiments grew out of some pot trials made by Lawes as a young man in the late 'thirties. The first result was the discovery of superphosphate, which alone had proved of almost incalculable benefit to the world, markedly increasing the yields of some of the British and Continental crops, and rendering possible the economic growth of wheat in Australia. Feeding experiments on animals came later, and proved of fundamental importance both to farmers and physiologists. During the fifty-seven years of their partnership, Lawes and Gilbert had investigated most of the important problems connected with British agriculture, and laid the whole community under a great debt of obligation to them. The work thus begun had expanded considerably under Mr. Hall's directorship (1902–12), and the growth was such that the new wing was already full, and the director, Dr. Russell, was preparing plans for new buildings to be erected in commemoration of the centenary of the birth of Sir John Lawes (1814) and Sir Henry Gilbert (1817). Mr. Runciman expressed the hope that the centenary fund would be well and widely supported.

MR. GEO. OTIS SMITH, director of the U. S. Geological Survey, on June 30 addressed the following letter to members of the survey:

Secretary Lane to-day presented Mr. Brooks with the Conrad Maltebrun gold medal which he had received from Paris through the Secretary of State. In making this presentation Secretary Lane expressed himself so thoroughly appreciative of the investigative work of the survey that I regret that a stenographic report of his remarks is not available. He expressed himself as gratified that this honor had come to Mr. Brooks as the chief of the Alaskan division of the survey, and added that he, like his predecessors, had come to place large dependence upon Mr. Brooks's intimate knowledge of Alaska and its resources; and he regrets that such signal honors as this medal awarded by the Société de Geographie of Paris come so seldom to the workers in the government service.

Addressing also Messrs. White, Marshall, Grover and Spencer, who were present, Secretary Lane emphasized his appreciation of the fact that the Geological Survey and other branches of the Department of the Interior include among their members men who are giving their very best service to the government and are actuated by the highest patriotism. To-day at Gettysburg men are receiving the honor due them for their services of fifty years ago, but these men who are serving the government to-day are no less worthy of medals for heroism and of other honors, as well as old age pensions, than are the veterans of the civil war, but the day will surely come when due recognition will be given to the civil service. In the meantime, however, it will be the endeavor to recognize the worth of these leaders in scientific investigation and so far as possible to entice them away from outside employment where their remuneration would be larger.

In his response, Mr. Brooks told the secretary that he felt his indebtedness not only to his associates in the Alaskan work, but also to those in charge of the field branches of the survey, which have trained the geologists, topographers and engineers for service in Alaska, and thus made possible the success of these investigations. Others, he said, throughout the survey had done the work, and the medal had come to the chief of the Alaskan division.

THE zoological expedition to Colombia of the American Museum of Natural History returned early in May, after an absence of four months. As we learn from the *Journal* of the museum the objects of the expedition were first, to collect material for a habitat group illustrating the bird life of the Magdalena Valley; second, to complete the ornithological survey of the Colombian Andes, begun

in 1910; third, to ascertain definitely the limits of the so-called Bogotá region whence, for the past seventy-odd years specimens collected by natives, but unaccompanied by data of any kind have been received; fourth, to collect a series of topotypical specimens from the Bogotá region. The expedition included Mr. Frank M. Chapman, and Messrs. George K. Cherrie, first assistant, Louis Agassiz Fuertes, artist, Thomas Ring, Paul G. Howes and Geoffrey O'Connell, volunteer assistants. This party left Barranquilla on January 19, and during the voyage of twelve days up the Magdalena River to Honda, by taking advantage of every opportunity when the boat stopped for cargo or fuel, collected three hundred birds. Studies for the habitat group were made at El Consuelo, on the western slope of the Eastern Andes, 2,700 feet above Honda; from this point a superb view is had of the Magdalena Valley, through which the river winds picturesquely, while in the background the Central Cordillera rises crowned by the three great snow peaks, Tolima, Isabel and Ruiz, each of which has an approximate altitude of 18,000 feet. Having completed its work in this region, the expedition journeyed by mule to Bogotá, making this city its headquarters during the remainder of its stay in Colombia. From Bogotá it passed first to the eastward to Villivicencio, at the eastern base of the Andes, stopping *en route* at all favorable localities. On reaching Villivicencio, the section through the Andes from the Pacific coast to the upper drainage of the Orinoco was completed, and data are now in hand for the determination of the altitudinal life zones of the Colombian Andes. A month later the expedition returned to Bogotá and passed southward to Fusugasuga, encountering there entirely different species from those which it had met with in its journey to the eastward. In all, some 2,300 birds and about 100 mammals were secured, and the diversity and richness of the avifauna is illustrated by the fact that no less than 505 species of birds were secured during the comparatively brief period when the expedition was actually in the field.

At the annual meeting of the American Association for Cancer Research, May 5, 1913, the following resolution (the report of the committee on statistics and public education) was unanimously adopted: "It is the sentiment of this association that: (1) the present instruction of medical students in the symptoms and early diagnosis of cancer is seriously deficient; (2) the medical curriculum should include special lectures in the clinical departments dealing specifically with this subject; (3) the universities should provide competent lecturers in this subject to address the local medical societies; (4) the associate members of the association should be urged to take up the question of the proper methods of approaching the public on the subject of cancer; (5) the activities of this association should at present be chiefly confined to the education of the medical profession; (6) this resolution shall be sent to the deans of the medical schools and the secretaries of the state medical societies in the United States and published in the medical press."

UNIVERSITY AND EDUCATIONAL NEWS

Public bequests aggregating $170,000 are provided in the will of Charles D. Sias, of Boston. Dartmouth College, the University of Vermont and Montpelier, Vt., Academy will eventually receive $15,000 each.

Mrs. Gustavus F. Swift and her son, Mr. Edward F. Swift, of Chicago, recently gave $10,000 toward the maintenance of the college of engineering of Northwestern University—an annual contribution since the opening of the college of engineering in 1908. Mr. Joseph Schaffner, of Hart, Schaffner and Marx, of Chicago, has given $12,500 toward the maintenance of the school of commerce of the university.

Miss Jeanie Pollock, of Glasgow, has bequeathed £10,000 to Glasgow University for providing a materia medica research lectureship.

The Atlanta College of Physicians and Surgeons and the Atlanta School of Medicine have been consolidated under the name of the Atlanta Medical College.

Dr. John H. Long, professor of chemistry in Northwestern University since 1881, has

been appointed dean of the school of pharmacy of Northwestern University, to succeed the late Oscar Oldberg.

DEAN DAVID KINLEY, of the graduate school, University of Illinois, has been elected vice-president of the university for one year beginning July 1, 1913, at the meeting of the trustees on July 2. He succeeds Dr. T. J. Burrill, who retired from active duties last year.

ALEXANDER GEORGE MCADIE, professor of meteorology in the Weather Bureau and director of the California climate section, has been elected director of the Blue Hill Observatory and professor of meteorology at Harvard University.

DR. F. J. ALWAY, head professor of agricultural chemistry in the University of Nebraska and chemist of the Nebraska Agricultural Experiment Station, has been appointed professor of soil chemistry and chief of the division of soils in the University of Minnesota. Dr. Fred Upson, of the University of Chicago, has been appointed to succeed Dr. Alway in the University of Nebraska.

DR. JAMES R. NYDEGGER, of the United States Public Health Service, has been elected professor of tropical medicine in the University of Maryland.

MR. W. G. FEARNSIDES, fellow and lecturer in natural sciences at Sidney Sussex College, and demonstrator in petrology in the University of Cambridge, has been appointed to the Sorby chair of geology at Sheffield University.

DISCUSSION AND CORRESPONDENCE

NOMENCLATURE IN PALEONTOLOGY

TO THE EDITOR OF SCIENCE: I ask the courtesy of your columns to explain certain allusions in a recent contribution which seem to have been somewhat misunderstood by my good friend Dr. Peale. In criticizing a prevalent custom in vertebrate paleontology of identifying as to genus and species very fragmentary material which is not really exactly identifiable, I spoke of its having "sadly misled" him into presenting as conclusive evidence of identity in age a correspondence in fauna (*i. e.*, in the fauna as listed) that was really no evidence at all. The criticism was in no wise directed at Dr. Peale, as he seems to suppose, nor at individual vertebrate paleontologists, but at a prevalent custom in this branch of science which I think ought to be amended. Naturally, Dr. Peale is perfectly justified in depending upon the published lists (*if* they have not since been criticized or amended or new and better evidence secured); and vertebrate paleontologists are presumably justified in following the customs of their tribe. But this is a vicious custom, and the fact that it misled so eminent a stratigrapher was cited as an instance of the harm it does.

Dr. Peale finds it "interesting to have a vertebrate paleontologist make the statement that 'correspondence in fauna is not conclusive evidence of identity in age.'" Well, I am not so rash as to say that it *is*, without making a number of reservations as to adequacy, presentation and interpretation of the evidence, etc. (for certain other considerations see article in *Bull. Geol. Soc. America* for 1913, p. 283). But I did not make the statement he attributes to me, if I understand the meaning of words, and considering the context in which I was using them in the cited article. I was discussing faunal lists based upon specimens too fragmentary for exact identification. Such a "correspondence in fauna" is *not* conclusive proof of identity in age. That does not mean that vertebrate paleontology has no place in stratigraphic geology. Fossil vertebrates, provided the material is adequate and the identifications correct, afford a much more exact geological timepiece than do invertebrates or plants. But the material is always scanty and often inadequate, and the degree to which this is true must in each case be taken into consideration in interpreting their evidence. Furthermore, owing partly to the greater exactness of our timepiece, we are conscious of certain normal deviations from accuracy—if one may so speak—regional, environmental, etc., which although their effects upon the existing flora as well as fauna are obvious

enough, are not always considered by paleobotanists and stratigraphers.

It should be noted that my criticism was limited to the inference that the evidence from vertebrate paleontology as cited was conclusive in this problem. I have expressed no opinion as to the validity of Dr. Peale's conclusions in regard to the age of the Judith River fauna, chiefly because the subject is under investigation and the evidence is not all in yet. Mr. Barnum Brown has spent four or five months of nearly every year from 1899 to the present date, in collecting vertebrate and other fossils for the American Museum from the Lance, Hell Creek, Judith River, Ojo Alamo, Edmonton and Belly River beds, most of which are or have been included under the broad designation of the Laramie Group.[1] He has secured a large amount of fine material, made extensive observations on the stratigraphy, and kept accurate records of the location and level of his finds. Certain other parts of the problem are under investigation by Messrs. Granger and Sinclair in New Mexico and Wyoming. Until these data have been compared, studied and coordinated with those previously published, it seems better to retain an open mind in regard to the tenor of the evidence from fossil vertebrates on the Laramie question.

W. D. Matthew

American Museum of Natural History,
July 1, 1913

MENDELIAN FACTORS

To the Editor of Science: The alternative interpretation proposed by Dr. Henri Hus[2] for ratios found in F_2 crosses between sweet and waxy varieties of maize, suggests the question whether we are to use Mendelian factors merely as a form of notation to aid in the orderly arrangement of certain facts of heredity, or go further and insist that they have a real existence. The observed ratio of 9 horny seed, 3 waxy seed and 4 sweet seed was represented as resulting from the interaction of two factors, a factor S for sweet endosperm and a factor X for waxy endosperm. The presence of both S and X was assumed to result in horny endosperm. In the self-pollinated progeny of a sweet-waxy hybrid, both S and X would be present in 9 out of every 16 seeds and this was the number of horny seeds observed. X alone would occur in 3 out of 16, the ratio in which the waxy seeds occurred. S would also occur alone in 3 out of 16 seeds, but the number of sweet seed was found to be 4 instead of 3 out of 16. On this hypothesis, therefore, the one seed out of every 16 which would have neither X nor S was included with the sweet seeds.

Dr. Hus's proposed changes are in effect to substitute W for our X, H for our S, and to add a common factor called S to all the members involved.

To the writer the only object in premising factors at all is that by their use predictions are made possible, and in the present case two factors are adequate for this purpose. To assume a third factor is like adding an unknown constant to both sides of an equation.

The test proposed by Dr. Hus for the reality of the H factor is the same as one of the tests originally outlined as a test for the same factor which we called S. What is needed to prove the superiority of the formula proposed by Dr. Hus is some method of testing the reality of the common basic factor. Until some plant is discovered in which the basic character is absent there appears to be no way of doing this. The presence of a factor can neither be demonstrated nor disproven so long as it is assumed to be universally present.

When sweet and horny were the only alternative kinds of endosperm known the presence and absence of a single factor was adequate to make predictions regarding their behavior. With the discovery of waxy endosperm it was necessary to add a second symbol. But until another form comes to light it is difficult to understand how a third symbol helps us to an understanding of the inheritance of these characters.

If the symbols are taken to represent actual entities it is of course anomalous to have a

[1] Not in the Laramie *formation* as now limited by the U. S. Geological Survey.

[2] Science, June 20, 1913, p. 940.

character represented by the absence of all factors. But in avoiding this anomaly, calculation is made more difficult and the only object gained is to lend an unwarranted appearance of reality to what is merely a convenient formula for expressing the observed relations.

G. N. COLLINS

WASHINGTON, D. C.,
June 30, 1913

SWEDENBORG

TO THE EDITOR OF SCIENCE: At the top of the second column of page 100 of SCIENCE for January 17, 1913, I note the following statement by one of your correspondents: "But Swedenborg would be laughed out of a modern court of science."

I find in a brief Life of Swedenborg, by J. Stuart Bogg (Frederick Warne & Co., London and New York, 1911), that Swedenborg was a wide traveler, a friend of learned men, a student of astronomy, metallurgy and anatomy, an inventor, a practical-minded, useful member of the Swedish House of Nobles, assessor in the Royal College of Mines and an author of numerous scientific works. Among his inventions were a plan for a submarine boat and a plan for a flying machine based on the now known principles of heavier-than-air machines. He declared that a very slight force would be sufficient to keep such machines up, but he knew nothing, of course, of gasoline motors. In the domain of astronomy he originated a method for finding terrestrial longitude by means of the moon. In the House of Nobles he took an active interest in such matters as the finances of the country, the liquor traffic and the mines. Among his scientific publications were works on chemistry, metallurgy, astronomical methods, observations connected with the physical sciences, and the economy of the animal kingdom. Until he was fifty-five years of age he was wholly occupied in these scientific and practical pursuits and was respected by scholars and patrons of learning at home and abroad.

In a prospectus which lies before me of a new edition of Emanuel Swedenborg's Scientific Works, I see that "Swedenborg's discoveries and theories in various departments of science have awakened an increasing interest among specialists during the past century," that they led the Royal Swedish Academy of Sciences to appoint a Swedenborg committee in 1902, and that this academy had in 1907 already published Vol. I. of the new edition in the original Latin and Swedish.

In view of these facts it seems strange to me that any one should affirm that "Swedenborg would be laughed out of a modern court of science." Is it possible that those who would laugh him out have never read his scientific works at all? If so, perhaps they could profitably reflect on the following quotation from Herbert Spencer:

> There is a principle which is a bar against all information, which is proof against all argument, and which can not fail to keep a man in everlasting ignorance; this principle is contempt prior to examination.

ANDREW H. WARD

A NEW VARIETY OF JUGLANS CALIFORNICA WATSON

THERE recently appeared in these columns a brief note by N. B. Pierce entitled "A New Walnut." It included a very brief general description which could not be accepted as a diagnosis in the usual meaning of that term. Yet Dr. Pierce stated that he thought it desirable to give the new form a name at that time and that he intended to publish a full description later. But Dr. Pierce did not see fit to cite the diagnostic description of this form which was published (but without reference to a scientific name) in Jepson's "Silva of California."[1] Had he done so the name he proposed would stand, even though unsatisfactory to one who has studied the form carefully.

However, I take it that *Juglans quercifolia* Pierce is a *nomen nudum* and that it still remains to publish a scientific name and diagnosis *together*. Therefore, I take pleasure in recording the same as follows:

New Variety: Juglans californica var. *quercina*. Diagnosis by the undersigned in

[1] Jepson, W. L., "Silva of California," Univ. Calif. Memoirs, Vol. II., 1910, p. 54.

Jepson's "Silva of California,"[2] the same to be reprinted under the above name in University of California Publications, Agricultural Science Series, Vol. II., No. 1 (now in press).

The chief reason for describing this form as a variety rather than a species is that *it does not breed true.* Several tests of seeds from different trees of this form have been made by the writer and in all but one test a number of the seedlings (never the same proportion) are typical *J. californica* in leaf characters. Obviously this is sufficient proof of a relationship which it is highly desirable to indicate by the name employed.

The reason for rejecting the name *quercifolia* is that the leaves are *not* oak-like. They resemble leaves of certain species of *Rhus* more than oaks. For this reason the writer had considered *anacardifolia* as a name, but the leaves are very unlike those of some species of the Anacardiaceæ. On the other hand, in general appearance of the trees this walnut does resemble a small-leaved oak. This is largely due to the habit of growth, the small size of the leaves and the dark green color of the foliage. Hence the name *quercina* is deemed proper, especially when used in varietal rank.

E. B. Babcock

[2] *Ibid.*

SCIENTIFIC BOOKS

Principia Mathematica. By Alfred North Whitehead, Sc.D., F.R.S., Fellow and late Lecturer of Trinity College, Cambridge, and Bertrand Russell, M.A., F.R.S., Lecturer and late Fellow of Trinity College, Cambridge. Cambridge University Press. 1912. Vol. II. Pp. xviii + 772.

Differential and Integral Calculus. An Introductory Course for Colleges and Engineering Schools. By Lorrain S. Hulburt, Collegiate Professor of Mathematics in the Johns Hopkins University. New York, Longmans, Green and Co. 1912. Pp. xviii + 481.

An Elementary Treatise on Calculus. A Textbook for Colleges and Technical Schools. By William S. Franklin, Barry MacNutt and Rollin L. Charles, of Lehigh University. Published by the authors. South Bethlehem, Pa. 1913. Pp. vi + 292.

The Calculus. By Ellery W. Davis, Professor of Mathematics, the University of Nebraska, assisted by William C. Brenke, Associate Professor of Mathematics, the University of Nebraska. Edited by Earl Raymond Hedrick. New York, The Macmillan Company. 1912. Pp. xx + 446.

Readers who desire to gain with a minimum of effort a fair knowledge of the nature, magnitude, method and spirit of Messrs. Whitehead and Russell's great undertaking and achievement may be referred to the *Bulletin of the American Mathematical Society,* Vol. XVIII., and to Science for January 19, 1912, where will be found somewhat extensive reviews of Vol. I. of the "Principia." The immensity of Vol. II., together with its exceedingly technical content and method, make it undesirable to review this volume minutely in this journal, and the purpose of this notice is merely to signalize the appearance of the work and to indicate roughly the character and scope of its content.

Owing to the vast number, the great variety and the mechanical delicacy of the symbols employed, errors of type are not entirely avoidable and the volume opens with a rather long list of "errata to Volume I." The volume in hand is composed of three grand divisions: Part III., which deals with cardinal arithmetic; Part IV., which is devoted to what is called relation-arithmetic; and Part V., which treats of series. The theory of types, which is presented in Vol. I., is very important in the arithmetic of cardinals, especially in the matter of existence-theorems, and for the convenience of the reader Part III. is prefaced with explanations of how this theory applies to the matter in hand. In the initial section of this part we find the definition and logical properties of cardinal numbers, the definition of cardinal number being the one that is due to Frege, namely, the cardinal number of a class *C* is the class of all classes similar to *C*, where by "similar" is meant that two classes are similar when and only when the elements

of either can be associated in a one-to-one way with the elements of the other. This section consists of seven chapters dealing respectively with elementary properties of cardinals; 0 and 1 and 2; cardinals of assigned types; homogeneous cardinals; ascending cardinals; descending cardinals; and cardinals of relational types. Then follows a section treating of addition, multiplication and exponentiation, where the logical muse handles such themes as the arithmetical sum of two classes and of two cardinals; double similarity; the arithmetical sum of a class of classes; the arithmetical product of two classes and of two cardinals; next, of a class of classes; multiplicative classes and arithmetical classes; exponentiation; greater and less. Thus no less than 186 large symbolically compacted pages deal with properties *common* to finite and infinite classes and to the corresponding numbers. Nevertheless finites and infinites do differ in many important respects, and as many as 116 pages are required to present such differences under such captions as arithmetical substitution and uniform formal numbers; subtraction; inductive cardinals; intervals; progressions; Aleph null, $\aleph_0$; reflexive classes and cardinals; the axiom of infinity; and typically indefinite inductive cardinals.

As indicating the fundamental character of the "Principia" it is noteworthy that the arithmetic of relations is not begun earlier than page 301 of the second huge volume. In this division the subject of thought is relations including relations between relations. If R_1 and R_2 are two relations and if F_1 and F_2 are their respective fields (composed of the things between which the relations subsist), it may happen that F_1 and F_2 can be so correlated that, if any two terms of F_1 have the relation R_1, their correlates in F_2 have the relation R_2, and *vice versa*. If such is the case, R_1 and R_2 are said to be *like* or to be *ordinally similar*. Likeness of relations is analogous to similarity of classes, and, as cardinal number of classes is defined by means of class similarity, so relation-number of relations is defined by means of relation likeness. And 209 pages are devoted to the fundamentals of relation-arithmetic, the chief headings of the treatment being ordinal similarity and relation-numbers; internal transformation of a relation; ordinal similarity; definition and elementary properties of relation-numbers; the relation-numbers, 0_r, 2_r and 1_s; relation-numbers of assigned types; homogeneous relation-numbers; addition of relations and the product of two relations; the sum of two relations; addition of a term to a relation; the sum of the relations of a field; relations of mutually exclusive relations; double likeness; relations of relations of couples; the product of two relations; the multiplication and exponentiation of relations; and so on.

The last 259 pages of the volume deal with series. A large initial section is concerned with such properties as are common to all series whatsoever. From this exceedingly high and tenuous atmosphere, the reader is conducted to the level of sections, segments, stretches and derivatives of series. The volume closes with 58 pages devoted to convergence, and the limits of functions.

To judge the "Principia," as some are wont to do, as an attempt to furnish methods for developing existing branches of mathematics, is manifestly unfair; for it is no such attempt. It is an attempt to show that the entire body of mathematical doctrine is deducible from a small number of assumed ideas and propositions. As such it is a most important contribution to the theory of the unity of mathematics and of the compendence of knowledge in general. As a work of constructive criticism it has never been surpassed. To every one and especially to philosophers and men of natural science, it is an amazing revelation of how the familiar terms with which they deal plunge their roots far into the darkness beneath the surface of common sense. It is a noble monument to the critical spirit of science and to the idealism of our time.

Of the making of many text-books of the calculus there is no end. The phenomenon is doubtless due to a variety of causes, literary, economical, scientific and educational. Chief among the causes is the felt desirability of producing text-books of mathematics that will

work the miracle of pleasing at once mathematicians who are not engineers and engineers who are not mathematicians.

Perhaps the most notable feature of Professor Hulburt's book is the excellence of its English. No doubt mathematical truth is like other scientific truth in the characteristic respect that its significance does not depend primarily upon the form in which it is expressed. It ought not to be forgotten, however, that its accessibility does depend upon its form. A loose definition of a mathematical term is not a mathematical definition. A vague statement of a proposition is not a statement of a mathematical proposition. Discourse that is not precise, cogent and concatenative is not mathematical discourse. For some unexplained cause departments of English fail to give their pupils such facility in English expression as is available for mathematical purposes. And those whose fortune it is to teach undergraduate mathematics find it necessary in classroom to devote half their time and energy to trying to secure on the part of their pupils decent, I do not say elegant or imposing or fine, but merely decent expression of ideas. In this important matter, an excellent model is of very great assistance, and such a model Professor Hulbert has furnished. Most excellence is excellence of emphasis. In this respect, too, the book is a model; doctrines are presented in perspective. The nature of the differential and the utility of the differential notation are made perfectly, unmistakably, intelligible—something that unfortunately can not be said of some current presentations. As to the order of themes, there may be difference of judgment. Integration is introduced on page 175. Practise in integrating is recommended and afforded before the use of tables, given at page 190. Teachers will value the introduction to analytical geometry of three dimensions, page 265. Taylor's series is presented as late as page 349. The work closes with an excellent account of simple differential equations, and a list of answers to exercises distributed throughout the volume. Printing and binding are well done and the page pleases the eye.

In the composition of their interesting work, Messrs. Franklin, MacNutt and Charles have been guided by certain convictions. For example, they believe that "to break the thread of the textual discussion by unnecessary algebraic developments and by large and frequent groups of purely formal problems," as is commonly done, is a "really hideous feature"; and they have sought to avoid such a blemish by relegating the majority of the formal problems to an appendix. This plan has not prevented them, however, from introducing a plenty of exercises into the body of the text. Again, they are convinced that, very unfortunately, nearly all scientific text-books carry the "false suggestion of completeness and finality," and, accordingly, in order to guard the reader against gaining such an impression from their book, the authors have very laudably given in an appendix "a carefully selected list of treatises on mathematics and on mathematical physics." The book is notable for the pains the writers have taken to keep the science of the calculus attached to reality, and everywhere throughout the work one detects the odor of physical science. On this account, perhaps, theoretical developments seem to have suffered in comparison, sometimes even consciously, as in case of the notions of infinitesimal, differential, divergence and curl. Indeed the authors characterize the articles dealing with these ideas as "fallacious," "mere plausibilities," and as being such that "the harder one tries to understand them the more vague and unintelligible they become." We are disposed to think that the authors, if not too modest and frank, have overrated the difficulty of presenting the matters in question soundly and clearly. The final chapter, 43 pages, is devoted to an elementary exposition of vector analysis, an element of the book that many will gladly welcome.

Professors Davis, Brenke and Hedrick have produced a very teachable book. It would be more pleasing if the print were larger and the pages less crowded. In an unusual degree one finds here the spirit of the calculus. Designed equally for the college and the engineering

school, the volume is rich alike in fine theoretical considerations and in varied applications. Theory, however, is not overdone and the applications are chosen with unusual regard to their intelligibility.

C. J. KEYSER
COLUMBIA UNIVERSITY

Instinct and Experience. By C. LLOYD MORGAN, Professor in the University of Bristol. New York, The Macmillan Company. 1912. Pp. xvii + 299.

"Once more I urge that the more clearly we distinguish the scientific problems from the metaphysical problems the better it will be both for science and for metaphysics" (p. 292). This, the concluding sentence of Professor Morgan's book, suggests the tenor of his discussion.

The volume is the direct outcome of a symposium on instinct and intelligence which was held in London in the summer of 1910. The several papers contributed to the symposium were published in the *British Journal of Psychology,* Vol. 3, 1909–10. Professor Morgan's views concerning instinct and intelligence differed in many respects from those of certain of the other speakers, and in the present work he has, at some length, presented and defended them in contrast with those of Messrs. Myers, McDougall and Stout.

Although the author would doubtless resent the suggestion, the reviewer looks upon this work as philosophical rather than purely scientific in nature. It deals largely with definitions, relations, speculations and presuppositions, and with attempts to draw a line between the naturalistic and the metaphysical disciplines. This is undoubtedly a profitable task from Professor Morgan's standpoint, but from the reviewer's it is decidedly less profitable than attempts to supply the deficiencies in our knowledge of instinct and intelligence.

And yet Professor Morgan insists, even in his opening paragraph, "My aim is to treat the phenomena of conscious existence as a naturalist treats the phenomena of organic life. I shall therefore begin with instinctive behavior and shall endeavor to give some account of the nature of the instinctive experience which, as I believe, accompanies it. In this way we shall get some idea of what I conceive to be the beginnings of experience in the individual organism" (p. 1). From this statement, one might suppose that the book would be devoted chiefly to the phenomena of instinctive and intelligent behavior, rather than to a consideration of the relations of instinct and experience or of the necessity of avoiding metaphysical problems.

Resting his contention upon the physiological discoveries of Sherrington and his coworkers, Professor Morgan insists that we must, in the end, distinguish instinctive from intelligent activities by describing the changes which occur in the central nervous system. The instinctive is dependent upon subcortical processes; and the intelligent, by contrast, is dependent upon cortical processes.

Throughout the book, but especially in Chapters II., The Relation of Instinct to Experience, III., Reflex Action and Instinct, and IV., Hereditary Dispositions and Innate Mental Tendencies, the importance of studying the functions of the central nervous system in their relations to different forms of activity is emphasized.

Effective consciousness, by which the author means consciousness that has something to do with the form of behavior, is supposed to be "connected with the process of profiting by experience" and to be "correlated with" the functions of the cerebral cortex. There is every reason, the author contends, to attempt to write a natural history of effective consciousness, a natural history of experience "as it somehow actually runs its course."

Concerning the doctrine of epiphenomenalism, the author observes that we have no proof whatever that the same brain processes which occur in connection with intelligent activity, accompanied by consciousness, ever occur in precisely the same way when these accompaniments are lacking. Professor Morgan does not believe that behavior would remain the same if the cerebral processes occurred without "correlated intelligence" (p. 262).

At the very beginning of life, inherited mechanisms are set going by appropriate situations. The reaction complex is instinctive. But immediately, if the organism possesses a cortical mechanism, profiting by reaction commences and each new performance, each new response to a given situation, in some measure modifies the creature, and by adding to its sum of experience, renders it more intelligent. Professor Morgan does not seriously discuss the question of whether intelligence or experience may exist in organsms which do not possess a cerebral cortex.

The author's conception of the relation between instinct and emotion is thus stated: "When a specific situation affords an appropriate constellation of stimuli, there issue reflexly from the subcortical centers two sets of efferent impulses, (1) those which evoke a specific mode of instinctive behavior, including those motor responses which constitute much of the so-called emotional expression; (2) those which evoke visceral disturbance—changes of heart-beat, and of the respiratory rhythm, modifications of the digestive and glandular functions, alterations in the peripheral vascular flow, a diffused influence on the general cœnæsthesis and so forth. From all this complex of bodily changes under (1) and (2) afferent impulses come into the central nervous system, and, when they reach the cortex, qualify the experience of the presented situation and thus complete the instinctive experience with its accompanying emotional tone. I regard it as probable that, in its primary genesis, the emotional tone is in large measure correlated with the cortical disturbance due to stimulation which is visceral and cœnæsthetic in origin" (p. 112).

In the final chapters of the book, VII., The Philosophy of Instinct, and VIII., Finalism and Mechanism: Body and Mind, Professor Morgan offers a critique of the views of Mr. Bergson, together with comments on those of Messrs. Myers, McDougall and Driesch.

The book is clearly and persuasively written and will undoubtedly prove agreeably profitable to readers who approach it as a general philosophical discussion of the subject, rather than as a contribution to the science of behavior. The reviewer's sole objection to the discussion is that it meets no urgent need.

R. M. Yerkes

Glycosuria and Allied Conditions. By P. J. Cammidge, M.D.

The increase which has occurred within the past decade or so in the number of cases of glycosuria—an increase which is only in part due to refinements of diagnosis—is demanding the attention of a large number of investigators as to the causes which give rise to this condition.

Although the milder degrees of glycosuria are not associated with the other well-known symptoms of diabetes, yet the latter are liable gradually to develop unless great care and judgment be used in controlling the diet of the patient. To do this efficiently the physician must familiarize himself with the more strictly scientific work bearing on the history of carbohydrates in the animal body, and it comes to be of importance that for this purpose he should be able to procure reliable and up-to-date reviews of the work that has been done.

In the present volume, from the pen of a clinical worker, a praiseworthy account is offered of much of the recent work—both clinical and experimental—bearing on the causes and treatment of various degrees of glycosuria. It is, however, more particularly with the part of the book bearing on the purely scientific aspect of the problem that the present review is concerned.

In the first chapter the general chemical properties and relationships of the various carbohydrates are sufficiently explained for most purposes, greater details being offered in the form of an appendix. Too little attention is, however, given to the condition of carbohydrates in the blood, an omission which, in view of the large amount of recent important investigation, is rather disappointing. The statement on page 17 that the blood is of definite alkalinity is hardly in keeping with modern teaching.

The two chapters which follow are devoted to a description of the different processes used in the detection and estimation of the various sugars in urine. There is much unnecessary detail regarding methods that are practically obsolete and the reader is not sufficiently informed as to which of those described the author, from personal experience, would recommend him to employ. The use of charcoal for the clarification of turbid urine (for polariscope examination) is condemned, because of adsorption of some of the sugar (p. 98), but no mention is made of the prevention of this adsorption when acetone or acetic acid is present in the solution. The method described for the estimation of the sugar in blood is obsolete.

In the chapter entitled "Experimental Glycosuria" a clear and well-arranged account of the results of some of the more recent laboratory investigations on this subject is given. The author, probably because he has not personally participated in such types of investigation, does not attempt to offer much criticism of the work; as a rule, he merely restates the views of others, thus leaving the reader to draw his own conclusions. In several parts of this chapter, however, the subject matter is not brought up to date as, for instance, in connection with the supposed antagonistic action of the pancreatic and adrenal glands in the control of the amount of sugar in the blood. The paragraphs on the relationship of the thyroid and parathyroid glands to carbohydrate metabolism and "on a theory of the co-relation of the ductless glands" are one-sided and highly speculative.

The remaining chapters are devoted to a study of the various degrees of transient and persistent glycosuria met with in man. This is distinctly the most important half of the book, for, while giving a well-arranged review of the work of other investigators, important personal experiences of the author himself are presented. Although it would be out of place for us to review at all extensively, this clinical portion of the book, there are yet one or two criticisms which may be appropriate. The account of the behavior of the creatin-creatinin excretion in diabetes is not brought up to date; there is practically no mention of the recent observations on the changes in the amount of the blood-sugar in diabetes; the so-called pancreatic reaction in the urine is not described in sufficient detail to make it possible for one unfamiliar with the author's previous writings to apply it properly, or even to understand upon what principles the reaction depends. The author lays great stress on the existence of pancreatic disease in most cases of diabetes, but beyond giving the case histories of a few diabetics in which pancreatic lesions may have existed, he adds no further evidence in support of such a conclusion.

The chapters on metabolism and treatment are distinctly successful and should be most useful to those called upon to treat this disease.

Taking the book as a whole it is not too much to say that it ranks with the best that have been written in this field. It is conservative and does not, as many of its forerunners do, extol any "specific" treatment which can be applied in all cases. On the contrary, it is frequently insisted upon that every case of diabetes must be considered as a problem in itself, and that the treatment must be adjusted so as to meet the peculiar conditions which it exhibits.

J. J. R. MACLEOD

WESTERN RESERVE MEDICAL COLLEGE

SPECIAL ARTICLES

THE PREVALENCE OF BACILLUS RADICICOLA IN SOIL

THE fact that soils from fields where leguminous plants bear nodules upon their roots may be used as a means of introducing this type of nitrogen-fixing bacteria into barren soil shows clearly that the different varieties of *Bacillus radicicola,* the organism which causes the root nodules, find a congenial habitat in many kinds of soil. Aside from its manifestations in the symbiotic relationship with leguminous roots, however, practically nothing is known regarding the distribution

or function of *B. radicicola* as it occurs in nature. Within the past three years two authors, employing widely different methods, have attempted to supplement this rather meager information. With a rather comprehensive plan for tracing the functional activity presumably of nodule-forming bacteria from the soil, through pure culture conditions, and into root nodules again Gage[1] apparently confused himself with a variety of seemingly incompatible results, and by his unusual selection of descriptive terms heightened the indefinite character of his report; but even if his conclusions were absolutely correct no real advance has been made in our knowledge of the life history of *B. radicicola.*

A synthetic medium has been developed by Grieg-Smith,[2] who states that it is almost specifically selective for *Rhizobia.* It should be noted that *Rhizobia* is not defensible as a generic designation for *Bacillus radicicola.*[3] If the selective phenomenon of this culture medium were consistent for wide variations of soil flora and soil type, we should have in this medium a means for determining the approximate numbers of *B. radicicola* in any soil and their relation to other members of the microflora of the soil. The agar medium as described contains levulose, asparagine, sodium citrate, potassium citrate and tap water. At the time of using from 0.06 to 0.10 cubic centimeters of normal sodium carbonate is added to 10 cubic centimeters of the agar.

Plates of a medium prepared by these criteria were exposed to the air in the laboratory at Washington for 15 minutes. An average of four species of molds to the plate developed; also numerous species of bacteria, some of which were chromogenic. In order to compare the growth of molds in other media, there were exposed in various places in the laboratory petri plates containing beef agar, the nitrogen-free agar developed by us for isolating *B. radicicola,*[4] and Grieg-Smith's agar made with and without the addition of sodium carbonate. Table I. shows the results of these tests.

TABLE I

Number of Species of Molds Developing upon Various Media[5]

Beef Agar	Nitrogen-free Agar	Grieg-Smith Agar	Grieg-Smith Agar + Sodium Carbonate
1	3	5	4
3	2	2	2
—	1	3	2
2	3	4	4

Further tests were made by inoculating various cultures of bacteria into Grieg-Smith's agar, with the sodium carbonate added. Tubes of slanted agar were used and the organisms were streaked over the surface. The following organisms grew:

Sulphur yellow bacillus,
Bacillus coli,
Bacillus cloaca,
Micrococcus roseus,
Bacillus rossica,
Bacillus prodigiosus,
Staphylococcus aureus,
Bacillus mycoides,
Azotobacter beyerinckii (on petri dish),
Azotobacter chroococcum (on petri dish).

The following organisms did not grow:

Bacillus subtilis, black variety,
Bacillus radicicola isolated from vetch nodules,
Bacillus radicicola isolated from *Ceanothus* nodules,
Bacillus radicicola isolated from *Cycas* nodules,
Bacillus radicicola isolated from lima-bean nodules,
Bacillus radicicola isolated from alfalfa nodules.

[1] Gage, G. E., "Biological and Chemical Studies on Nitroso Bacteria," *Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten,* 2. Abt., Bd. 27, No. 1/3, pp. 7–48, 1910.

[2] Grieg-Smith, R., "Determination of *Rhizobia* in the Soil," *Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten,* 2. Abt., Bd. 34, No. 8/9, pp. 227–229, 1912.

[3] Kellerman, Karl F., "The Present Status of Soil Inoculation," *Centralblatt für Bakteriologie, Parasitenkunde und Infektionskrankheiten,* 2. Abt., Bd. 34, No. 1/4, pp. 42–50, 1912.

[4] Tap water, 1,000 c.c.; cane sugar, 10 grams; monobasic potassium phosphate, 1 gram; magnesium sulphate, 0.2 gram; shredded agar, 15 grams, with reaction adjusted to + 4 Fuller scale.

[5] Petri dishes opened for 15 minutes in the laboratory rooms at different times during the day. The figures are the averages of two plates for each exposure.

The growth of pure cultures of *B. radicicola* on this medium was further tested by the usual methods of poured plates in petri dishes. The relative suitability of the different media is shown in Tables II. and III.

TABLE II

Growth of B. radicicola in Grieg-Smith's Synthetic Media

Source	Strain	Media	
		Grieg-Smith's Agar	Grieg-Smith's Agar + Sodium Carbonate
Alfalfa............	No. 101	+	+
Alfalfa............	No. 134	—	—
Alfalfa............	N. Y. soil[6]	+	+
Alfalfa............	D. C. soil[7]	—	—
Cowpea............	No. 103	+	+
Crimson clover...	No. 156	+	+

TABLE III

Comparative Suitability of Different Media for the Growth of B. radicicola

Source	Strain	Grieg-Smith Agar	Grieg-Smith Agar + Sodium Carbonate	Nitrogen-free Agar
Alfalfa....	No. 153	—	+	+
Alfalfa....	No. 134	—	+	+
Vetch......	No. 151	—	—	+

Following the technique outlined by Grieg-Smith, direct isolation of *B. radicicola* was attempted from soil of three types: (1) soil used in potting plants at the Department of Agriculture greenhouses; (2) soil from Akron, Colo., taken from around the roots of *Astragalus falcatus* Lam., and known by check experiments to be able to inoculate the roots of *Astragalus sinicus* Linn.; and (3) soil from Ithaca, N. Y., which had been sterilized and inoculated with *B. radicicola* isolated from alfalfa nodules. The ordinary dilution technique was employed and dilutions of 1:100, 1:10,000 and 1:1,000,000 were taken. The agar was used with and without sodium carbonate, and the plates incubated five or six days at room temperature.

The greenhouse soil developed molds and various kinds of nonchromogenic bacteria on both media; on the media with sodium carbonate the Colorado soil developed molds and various kinds of nonchromogenic bacteria, while the media without the sodium carbonate gave an almost pure culture of one species; the New York soil gave pure plates with both agars. In observing these plates it was very noticeable that the agar with the sodium carbonate showed fewer colonies than the agar without it; this has been noticed in regard to both pure and mixed cultures.

The colonies selected for final test were those which resembled pure cultures of *B. radicicola*. The bacteria isolated from New York soil and from greenhouse soil were tested for their ability to infect alfalfa, and those from the Colorado soil were tested for their ability to infect *Astragalus sinicus*. These selections for tests were made because of previous empirical determinations of the inoculating power of these soils.

The tests were conducted in sand nearly devoid of nitrogen, moistened with Sach's solution from which the nitrogen compounds were lacking. Special glass jars designed to prevent contamination were employed for sheltering the plants which were grown from disinfected seeds. The plants grew well, considering the abnormal conditions to which they were subjected. At the expiration of 63 days the plants were taken from the jars and the roots carefully washed. Table IV. shows the inoculating power of the colonies selected from the petri plates of Grieg-Smith agar.

TABLE IV

Inoculating Power of Bacteria from Various Soils Isolated upon Grieg-Smith Agar

Plant	Source	Inoculation
Alfalfa	New York soil	+
Alfalfa	Greenhouse soil	—
Alfalfa	Uninoculated	—
Astragalus sinicus ..	Colorado soil	—
Astragalus sinicus ..	Uninoculated	Plants died.

[6] This test was made with New York soil furnished by Dr. B. M. Duggar, which he sterilized and then inoculated with a strain of bacteria isolated at Cornell University from alfalfa nodules.

[7] This test was made with District of Columbia soil which was sterilized and then inoculated with alfalfa bacteria, strain No. 134.

Since the New York soil contained only living organisms of *B. radicicola* known to be capable of inoculating alfalfa, the inoculation of alfalfa by the organism isolated from the New York soil was to be expected.

It seems fair to conclude that *B. radicicola* grows but sparingly and shows no especial characteristics upon synthetic agar made in accordance with the formula reported by Grieg-Smith, which seems to be no more selective than the synthetic agar we have employed for many years in the Washington laboratories, and is perhaps less selective than the congo-red agar described by one of us.[8] Further development of technique or of culture media will be required before we may hope to secure reliable data regarding the relative distribution and quantitative function of *B. radicicola* in the soil.

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SOME EFFECTS OF SUNLIGHT ON THE STARFISH

Starfish have been much studied for their reactions to light. Their general reactions and behavior have been well described by Preyer, von Uexkull, Jennings and others, and there is general agreement in the results recorded by these writers. Details of behavior of the different parts affected by light are for the most part meager or omitted.

The general reactions of *Asterias forbesii* are essentially like those described for other starfish and there is no reason to suppose that its reactions are essentially different in detail so far as it is possible to observe them. It has been previously shown by the writer[1] that certain parts of the animal are sensitive to light. It has further been found that there is a definite time reaction between the moment when the light strikes the sensitive parts and the moment when they show a definite visible response, and the general reaction which follows, provided the light has sufficient intensity.

Individuals without the pigment or "eye" spots react as definitely to light as do these with the pigment spots intact. This was also found to be true for *Echinaster* (Cowles). The upper surface, the sides of the rays, the ventral surface and the tube feet are sensitive to light, since they show a direct response to it. The dermal branchia also show response to light stimuli. The behavior of dermal branchia is of peculiar interest, since their retraction must influence the extent of the aerating surface of the animal. The sudden illumination of a ray or a spot on it causes a retraction of the parts illuminated. If the area is large there is a bending of the ray ventralward no matter what the direction of the source of light. Following this primary reflex, there arise movements which lead eventually to the general response or behavior. Three stages are recognizable. These are: the initial or direct effect of light; the local direct response of the parts affected, and lastly the general effect and reactions in response to the influence of the preceding changes. It is apparently through these interactions that the external stimulus is finally transformed into reaction and behavior through the vortex of metabolic changes in protoplasm.

Loeb has maintained that "reactions are caused by a chemical effect of light" and that "the velocity or the character of the chemical reactions in the photosensitive elements of both sides of the body is different," and hence "the muscles or the contractile elements on one side of the organism are in a higher state of tension than their antagonists." One wishes for more direct evidence and, if such is possible, direct proof that light does influence the chemical processes of normal metabolism, than the above assumptions afford. While it is generally assumed that light does cause chemical changes in organisms and these must influence the reactions of the organisms, there is a significant absence of direct experimental proof.

[8] Kellerman, Karl F., "The Relation of Crown-gall to Legume Inoculation," U. S. Department of Agriculture, Bureau of Plant Industry, Circular 76, p. 4, 1911.

[1] Science, N. S., Vol. 35, p. 119.

Jennings sought an explanation of behavior based on physiological grounds and concluded that since the organism may react differently under apparently similar conditions, reactions are due to differences in physiological states. He cites instances in which the physiological conditions, such as hunger, for example, are known to modify reactions.

Mast (1911, page 369) admits that the "belief that light in some way influences the activity of organisms by chemical changes which it causes in them" is founded on hypothetical assumptions. Any direct evidence either in agreement with or opposed to these views, although it may need further verification, would be of importance.

It must be remembered that little is positively known concerning the character of chemical changes in metabolic processes. It is true, however, that of the various physiological states, or conditions which might effect them, the maintenance of the neutral or slightly alkaline condition in an organism is of the greatest importance, and this condition is not easily changed. Any change in this state it should be possible to detect provided a proper means be found. It is assumed that the organization of protoplasm involves and demands physical-chemical relations and changes of a progressive kind, with some range of disturbance possible without causing complete disorganization or breaking down of the chain of changes. These changes must be maintained within the limits of the conditions which make possible their continued recurrence. This has aptly been likened to a "vortex."

The natural result of a stimulus breaking in upon these regular changes may be to stop some, accelerate others, divert others into combinations different from those which would normally occur. That the stimulus (light) would cause a chemical change which would be the cause of the reaction is limiting the possibilities. From the viewpoint of the physiological processes it becomes a matter of importance to discover the nature of these disturbances. As previously stated, an acid or alkaline condition is of primary significance, the right condition being maintained through the interaction of certain basic and acid substances present. If it is not possible to detect these conditions directly it might still be possible to discover variations in the amount of elimination of products or alteration in their character. Accordingly, an attempt was made to discover any possible difference in these conditions.

To test for differences in respiration in the starfish two methods were used. In one series of experiments an indicator for carbon dioxide was introduced into the given amount of sea water with the specimen to be tested. Parallel experiments, one in the shade and one in the sunlight and one control, were compared. In a second series specimens were exposed in the shade and the sunlight in equal amounts of tested sea water, the sea water then after equal intervals of time being again tested.

Having made use of neutral red in class observation on the reaction of protoplasm and vacuoles in *Paramœcia*, this was tried in the starfish. Furthermore, neutral red might also show differences in *intra vitam* staining in light and shade. Dilute solutions of neutral red were made in sea water which is normally slightly alkaline in reaction, from 1:10,000 to 1:60,000. A more dilute solution was used in some cases. Given amounts, 200 c.c. to 400 c.c. of the same solution were placed in each of three large clean finger-bowls. One of these was kept for control. Two starfish equal in weight and as nearly alike as it is possible to select, which were found to react normally to light were placed one in each of the other two vessels. One of these vessels was then placed in the sunlight and the other in the shade. Both vessels were placed in a shallow aquarium of fresh sea water in order to maintain equality of temperature 18° centigrade. At intervals of two or five minutes a careful comparison was made to note possible changes in activity and degree of staining shown by each specimen. In practically every experiment at the end of five minutes, solutions and specimens showed distinct differences. In the vessel in the shade the solution showed a characteristic acid reaction, while at the same time

the one in the sunlight showed a very distinctly less amount of change, but when compared with the control it gave evidence of change. The specimen in the shade was usually more distinctly stained by the neutral red than the specimen in the sunlight, and the solution in the shade was apparently clear after the lapse of fifteen to thirty minutes, while that in the sunlight still distinctly showed the stain in solution. As might be expected in some of the experiments, the differences were more distinct than in others. It is taken that the acid reaction is due to the elimination of carbon dioxide.

A toxic effect was also evident in the experiments in the sunlight due probably to the action of the basic elements of the dye. What this is still remains to be determined. It is apparently due to effect of sunlight on protoplasm influencing metabolism in such a manner that the injurious changes occur; or it may be the effect of sunlight on the interaction of the basic dye and protoplasm or its metabolic products. A similar effect is seen in experiments with *Paramœcia*. In the sunlight there is a greater concentration of the hydroxyl ions which would give an alkaline reaction. The outcome is that hydrolysis takes place which interferes with the normal processes and produces injury to the protoplasm. In the shade the hydrogen ions have a greater concentration with the more acid reaction.

As a check upon these results a second set of experiments was made in which the reaction of the sea water was tested in which the specimens were placed without the presence of the indicator. In this series equal quantities of sea water, after being tested with the most accurate apparatus, were placed with carefully selected individuals in clean glass vessels and arranged, as in the former series, in the sun and in the shade. In this series it was possible to use the same specimen for the test at different times after exposure for equal intervals of time in the sun and in the shade. The results agreed as closely as could be expected with those in the former series.

In testing the sea water in each case an N/10 solution of hydrochloric acid and an N/10 solution of sodium hydroxide, and phenolphtalein were used. It was found in a series of ten parallel experiments that at equal intervals of time after the lapse of about five minutes from the beginning of each experiment up to fifteen minutes, the sea water from the vessels in the sunlight showed less acid reaction than that taken from those in the shade. In four cases the sea water with the specimens in the sunlight remained slightly alkaline, but less so than the normal sea water; four showed a slightly acid reaction, the two remaining were neutral. Of the parallel series in the shade at the same intervals of time, seven showed an acid reaction, two were neutral and one was very slightly alkaline. Normal sea water is alkaline. It thus appears that the metabolic processes of protoplasm under these different conditions of illumination differ to a degree sufficient to affect the sea water through differences in elimination of the products of metabolism. It is to be remembered that ten or fifteen minutes is usually sufficient for continuous sunshine to cause a starfish to take up a characteristic fixed position with respect to the light in as protected a place as possible.

These experiments show that sunlight modifies the normal physiological changes taking place in protoplasm, checking some of the processes and probably accelerating others. It appears that the acid and alkaline relations are affected probably through a disturbance in the relations of the hydrogen and the hydroxyl ions. The starfish with one half of its upper surface in the light and one half in the shade moves from the light into the shade because of this interference with its normal physiological activities.

These experiments were performed in the Biological Laboratory of the Brooklyn Institute of Arts and Sciences, Cold Spring Harbor, Long Island, July and August, and I am under obligations to Dr. C. B. Davenport, the director of the laboratory, for the privileges and opportunities so kindly extended.

HANSFORD MACCURDY

ALMA COLLEGE,
October 3, 1912

SCIENCE

FRIDAY, JULY 25, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE MUTUAL RELATIONS OF MEDICAL PROGRESS AND THE PHYSICIAN[1]

SOME students of literature tell us that there are but seven different stories in the world. I should be inclined to add that there were but three different addresses for an occasion like the present.

Thus it is possible to select a chapter in medical history and revive the past; or discuss some striking achievement of the day and illuminate the present; or finally, to choose for consideration problems, the solutions for which are still in the making, and thus attempt to forecast and to mould the future.

It is from these problems that I have made a selection for this occasion and I purpose to speak on the mutual relations of medical progress and the physician—for you are physicians—in the nascent state, to be sure—but like the freshly liberated hydrogen to which the adjective is most often applied—capable of vigorous activity.

To say anything really new to you upon the topic here set down would be most difficult. We are all in the position of the old philologian who, when asked to explain why he gave no lectures, replied that he had not yet been able to get together a sufficient quantity of *new* facts to fill an hour. For the most part we who speak are obliged to overlook this unpleasant circumstance and endeavor to present familiar ideas in a new form—trusting by a happy presentation to drive them home.

To be sure, all of us are wonderfully pro-

[1] Address given at the eighty-fourth annual commencement of the St. Louis University School of Medicine, June 5, 1913.

tected against the infection of ideas—but it sometimes happens that our resistances are particularly low and if then the idea be "exhibited" in a peculiarly virulent form, it "takes" and the experiment is counted a success.

I turn now to the topic of the hour. The notion of progress which I wish to use neglects sheer turmoil and in a measure mere accumulative work—and puts the emphasis on our advance in leading ideas and guiding principles.

It is your relation then to such progressive changes in medicine, the effect which these changes have on your intellectual life and economic opportunities, and in return the influence which you, as physicians, can exercise on the advancement of your science, which I purpose to present.

My point of view is that of the laboratory man working in a field cognate to medicine, and my attitude is one of encouragement to yourselves and sympathy with the ills of the community that needs your aid.

By way of introduction let me call your attention to the fact that the idea of progress for humanity—so familiar to us now —is really rather new.

The most ancient view is well illustrated by an allegory taken from an Arabian manuscript of the thirteenth century. I use the translation given by Lyell in his "Principles of Geology."

It serves to show how, in the absence of sufficient records, changes may be easily forgotten, and it runs as follows:

I passed one day by a very ancient and wonderfully populous city, and asked one of its inhabitants how long it had been founded. "It is indeed a mighty city," replied he; "we know not how long it has existed, and our ancestors were on this subject as ignorant as ourselves." Five centuries afterwards, as I passed by the same place, I could not perceive the slightest vestige of the city. I demanded of a peasant, who was gathering herbs upon its former site, how long it had been destroyed. "In sooth a strange question!" replied he. "The ground here has never been different from what you now behold it." "Was there not of old," said I, "a splendid city here?" "Never," answered he, "so far as we have seen, and never did our fathers speak to us of any such."

On my return there five hundred years afterwards, I found the sea in the same place, and on its shores were a party of fishermen, of whom I enquired how long the land had been covered by the waters. "Is this a question," said they, "for a man like you? This spot has always been what it is now." . . .

Lastly, on coming back again after an equal lapse of time, I found there a flourishing city, more populous and more rich in beautiful buildings than the city I had seen the first time, and when I would fain have informed myself concerning its origin, the inhabitants answered me: "Its rise is lost in remote antiquity: we are ignorant how long it has existed, and our fathers were on this subject as ignorant as ourselves."

To the people of this legend not only was the past unknown, but for them the future also must have shaped itself as an endless prolongation of the present. To talk to them about the scientific use of the imagination would have been a thankless task. They merely drifted on the stream of time.

When, however, the historical records were at hand and the great events were noted, attention turned to the possible changes in man himself.

During the twelve hundred years when western Europe was adjusting itself to the new order of things, men looked back to the great classic past as something beyond repetition or improvement, counting its leading men as of a vanished race of intellectual prodigies.

In his studies on "The Mediæval Mind," Taylor quotes a writer of the time as follows:

Bernard of Chartres used to say that "we were like dwarfs seated on the shoulders of giants. If we see more and further than they, it is not due to our own clear eyes or tall bodies, but because

we are raised on high and upborne by their gigantic bigness."

Here it is conceded that men changed, but the change was rather backward and for the worse.

In harmony with this idea we find three centuries later, when Vesalius was founding modern anatomy, that the discrepancies between his observations and those of Galen—whose teachings were then dominant—were explained by the fact, that since Galen wrote, the human body had deteriorated.

It is only since we began to command the forces of nature through the development of chemistry and the power of steam that the modern notion of progress has taken a firm root, because only since then have important discoveries followed one another with sufficient frequency to give the impression of a progressive series.

At present we somewhat readily concede to the past the greater men, but when asked to compare ourselves with our representatives of an earlier time there is a strong inclination to conclude that we ourselves are the better, for we can do so many things which they could not.

When one looks critically at the matter and endeavors to distinguish between material advances and biological improvement, this illusion disappears. It is evident that despite the external changes, the human being has remained almost unmodified. Although the *average* length of life has been increased by conditions which permit a greater number of people to approach old age, yet we see no evidence that for the individual the normal span of life has been extended. Although we are more guarded from pestilence, famine and war, and relieved from the distractions which they cause, yet equivalent emotional strains have replaced these distractions. Although for a number of people the economic situation makes the pursuit of food and shelter a less insistent occupation than before, yet into the vacancy so left there stream at once new obligations and unexpected interests, while at the same time there is no evidence that our minds have become either more acute or more vigorous. Nevertheless, as heretofore, each of us must live on twenty-four hours a day.

In brief, then, social development protects us and the preservation of past accomplishments leaves us free to attempt new ones, but within historic times, man—the dominant power on the earth—has changed but very little, if at all, while here and there the best achievements of his remoter ancestors still mark the high levels of human thought.

Nevertheless, in a sense, our opportunities are much increased. The world, at least the active part of it, has been more firmly knit together. We can get our bodies, our voices or our writing carried about the earth at marvelous speed and with wonderful safety.

A few uncommon languages still hinder intercourse between the nations, but in the main it is easy to learn precisely what is going on now and what has gone on for the last fifty or a hundred years. Ideas travel with the ease of Aladdin and his friends and everywhere men are testing, trying, proving and attaining new results.

This opportunity to try rapidly and on a large scale any new ideas that require to be tested yields in return a great mass of conclusions and judgments which must be considered both quickly and seriously—lest confusion follow in their train.

As a consequence of this condition one has at least the opportunity to think more often and more rapidly than a generation ago—not because the modern mind is normally more active, but because the food for thought is more abundant and more varied.

At worst, this brings distraction; while at best, it makes us frugal and foresighted in our mental life. At every turn, therefore, the study of efficiency is forced upon us—all the way from the correct position of our inkstand on the desk to the arrangement of our thoughts.

The interests which pass before us in a ceaseless train may prove almost embarrassing in their abundance, unless we are prepared for the experience.

Thus a man often finds himself in a position analogous to that of the courteous gentleman who felt that one should always hold open for an approaching lady any swinging door. Once at the main entrance of a large department store he began this practise early in the day. Closing time found him still at his post, for never through the long hours had the stream of passing ladies been sufficiently intermittent to allow him to move on without some damage to his self respect.

I say we find ourselves in quite an analogous position to this with regard to current ideas, and for this reason many of them must be resolutely disregarded. It is something of an art to use a protective inhospitality towards these many vital interests without creating by this act a feeling of dislike for those excluded, and thus weakening one's sympathy by the lack of use.

We may recall here as having particular fitness that view which regards life as a continuous adjustment between internal and external conditions.

As we grow older this continuous adjustment is made only with increasing difficulty. We become enmeshed in our special habits and loaded down with our private information—so that we do not move lightly or change with ease.

Perhaps one of the most striking results of the rapidity with which new problems and new ideals follow one another is the attitude of the active world towards the man of sixty, or shall I say, fifty.

Time was when the progress of ideas in a community moved at so moderate a pace that by gaining much experience in youth, a man in old age could have a store of facts as the basis of wise judgments.

To-day we have the startling situation that the matters on which sound judgment is demanded often belong to a group of events and happenings that have occurred since the man interrogated was in a position to get the needed experiences.

Such a one may be wise in the matters to which his own growing period relates—but unfitted to meet the questions of the moment which so often arise from situations developed since that period was closed. So it sometimes happens that a man advanced in life may belong not to his own generation, but to that which has preceded it—and there is a misfit.

Yet experience is ever and always the foundation of wisdom, and it follows that the period of acquisition must be prolonged. The existence of this situation is beyond dispute. Some method of adjustment to it must be found, and, if need be, we must revise our intellectual manners. Speaking broadly, we have perhaps been leading a somewhat thriftless mental life and needlessly curtailing the period of growth.

Suffice it to say that the demands on our attention, numerous as they are to-day, are bound to be more numerous a decade hence, and the first practical step is to employ a method of selection among the things to which one attends. We must imitate the miner. Gold is pretty widely distributed. There is said to be one grain in every ton of sea water. The city of Philadelphia stands on a brick clay deposit which contains enough of this precious metal to buy

a navy. But to recover this gold would cost many times its worth. One obtains gold, to be sure, by working in these places, but only at a great price. The distribution of knowledge is analogous and one must work or mine—to continue the simile—only where it really pays to work and leave the scattered dust of information to be dealt with by more effective methods.

There is one further aspect of the increase in knowledge and the rapid alteration in point of view that still needs a word. One may safely predict that what you have learned of method and right reasoning, such experience as you have gained in the art of observation and induction and the criticism of your own conclusions, will stay with you throughout life. So will many of the bits of knowledge which have stood the test of years and thus inevitably survived many an assault. These are the relatively stable things, and by virtue of that fact they can be expressed in a few words, without elaboration.

I desire to impress on you, however, that we must regard the knowledge of our time for the most part, not as final or ultimate in any rigid sense, but merely as the best available at the moment—certain to be improved with the advance of time, while, nevertheless, valuable and worth while in so far as it aids us to control natural phenomena, like disease.

In holding that in large measure our knowledge is open to change and to improvement, often of a fundamental character, we admit that in this respect our generation is only a repetition of those gone before, and this admission should make us very sympathetic with the past. No earlier age is to be discredited because of its tools. Primitive man with his stone axe or copper knife is to be rated by the use he made of his simple inventions. Thus in medicine your predecessors are to be esteemed for the intelligence with which they used their rough instruments and fragmentary information. Nothing is more certain than that the generations which follow us will also need to mingle mercy with their judgments.

Your knowledge then and the principles with which you work must be regarded in a twofold way: for each present moment, fixed; but for the future, transient.

When an experiment is in progress to test an hypothesis, the hypothesis for the time must be held as if rigidly true, for it is the hypothesis which is to be examined.

When, however, repeated tests fail to support it, then it may perhaps be put in a psychological museum, as a matter of historic interest or relegated to the scrap heap —a procedure usually to be preferred. The reason for putting emphasis on this point of view is found in the fact that it is quite contrary to one which, I regret to say, has often been tacitly encouraged, namely: that by learning rather dogmatically certain things through a small number of years, one was thereby fitted to care for the sick, and also thereby largely relieved from the need for further mental growth. Against such doctrine it is my desire to protest.

Nothing could be more unfortunate if medicine is to be regarded as a science and an art. As a matter of fact, the mental attitude evolved from the study of medicine depends but little on the precise subjects to which attention has been given. One may have studied more or less in many given directions—but if in his studies he has been occupied with subjects involving important and fundamental ideas, topics therefore suitable for training, if his instruction has been received from men who were not only informed on their subject, but contributing to its advance, he is well prepared for the problems of the physician.

In the older days, especially in western

Europe and her colonies, the apprentice system was in vogue in medicine. Theoretically there is no better. The apprentice learns from his master the history and principles of his science, receives correction and encouragement and watches at close range the master's methods and the exhibition of his skill, and has the opportunity to try everything himself. The system suffers mainly from the paucity of masters.

In passing I should like to recall your attention to the fact that exactly these advantages were those urged for the laboratory method of instruction when the personal contact of the teacher with a few chosen students were the features emphasized, and these relations still remain the ones for which we strive. Yet in the competition between the several methods of instruction during earlier centuries the didactic form prevailed—for reasons too obvious to need recounting here. From the first the weaknesses of the method were apparent, but teachers were in a measure misled by the persistent hope that through the spoken or the written word or through the picture of a thing or act they could effect in the nervous system of the student those changes which the independent act and thought by the individual himself alone can cause. We now know that if an animal be carried through a maze—even many times—it does not learn its way. It must go itself. The same is true for man.

So at the present day more training of the eye and hand and of the powers of observation and of inference are demanded. These pave the way for the many attainments which are to be exercised within the frame set by the philosophy, history and scope of your science. Through these attainments and within this frame you are to work in the light of the best knowledge to be had, realizing that among these conditions knowledge is the least stable and the most likely to take a turn for the better. Nevertheless, when one has reached the point of view that our knowledge is in a constant flux, there are some common difficulties which at once appear. Guided by the conviction that learning advances, we are sometimes in our enthusiasm misled by the notion that each new thing is probably an addition to the fund of truth.

But old men shake their heads. The life of a new discovery has been said to be for three years, and after it has survived for that time, it too often fades away.

I have a personal interest in this matter, for the laboratory is my habitat. It must be admitted that the atmosphere there is sometimes such as to force intellectual fruit unduly, and it may even be put upon the market while still quite green; but we grow wiser with experience, even in the laboratory, and the future I am sure will contain proportionately fewer premature revelations than the past. But leaving aside the group of false alarms and false hopes which have gone far to discredit the influence of the laboratories, there still remain the significant and well-grounded results which they have furnished. To these the practitioner must be alive and responsive in the same manner as he is alive to clinical advance, and not allow either prejudice or indolence to stand in the way of his utilization of these new facts for the benefit of those whom he is called to aid.

When the ideal relation is established, as it surely will be, between the physician and the well springs of new knowledge, not only will the practitioner find continuous aid and stimulus coming from the laboratory, but in return will use his best efforts for the extension and increase of the work which laboratories do; substituting enthusiasm and cooperation for the less helpful relations which sometimes appear.

It must be admitted frankly that in this

presentation the obligation seems to rest heavily on the physician, for he is urged to welcome and incite the activities of those who are bound as a result of these to ask him continually to replace older by newer knowledge. But it must be remembered that the interests of the community enter as a factor here, and since the community is better served by this, the equation is well balanced.

Sometimes it would appear that the thought of service had departed from its ancient place of honor—but in truth, it has merely changed the form of its expression. In the olden time the long cross country drives of the friendly doctor to a distant patient were justly presented to us as part of the hardships of a devoted life. Now the scene has shifted a bit, long journeys over the literature, some of it often rather rocky and uneven, or hours devoted to tests and exact determinations in his office laboratory, or even to experiments which hazard life, take the place of the earlier expressions of devotion and accomplish the same end—they make the doctor a better man.

Thus far it has been my purpose to indicate the relation of the progress of medicine, either by laboratory work in the strict sense, or through careful and systematic clinical studies, to your own mental attitude and growth.

This, however, is but the first part of the story; the second part deals with quite another matter. The laboratory has altered the practical and economic situation of the physician in the last few years to an unprecedented degree, and it is concerning this alteration that I wish to say a word.

To-day no physician would remove to the Canal Zone with the idea of making his main practise among those suffering from yellow fever; nor would he to-day expect as an army surgeon to have a great experience with typhoid. In both these instances steps have been taken which lead to the elimination of the diseases named—they simply are not there. I use these instances merely as an illustration of the fact that the health of the community has been protected and bettered in various ways. Thus we recognize that there are mechanical devices sometimes directed against the pathogenic organisms themselves or sometimes against their hosts. Pure milk and pure water mean fewer typhoid organisms—the draining of marshes, fewer places in which pestiferous mosquitoes can breed. The mechanical protection of screens and traps keeps from us disease-bearing flies, and shoes go a long way toward blocking the entrance of the hookworm.

Moreover you have vaccines for smallpox and for typhoid, to name but two, the effect of which is to render the body inhospitable to the organisms against which they are directed. Even when the disease-bearing organism has established itself, it is possible in some instances to kill it within the host, as in the case of the malaria organism and the *Spirocheta pallida*.

When this can not be done and the pathogenic organism is not only active but entrenched—there are antitoxins available, as in the case of diphtheria, by which the poisons that are doing damage can be neutralized, and finally protection of the body in the widest sense can be accomplished by general hygienic measures, so that the inroads of such persistent but unapproachable organisms as the tubercle bacillus may be blocked and prevented.

It is, however, not my object to give a discourse on preventive medicine or public hygiene, but merely to point out that a great deal has been accomplished in bringing under control a number of diseases which heretofore have been treated by the physician single-handed.

Thus one of the ideals of the profession—namely, the prevention of disease—has in recent years made advances toward realization beyond the dreams of the most sanguine a generation ago.

Medicine, like the law, is in a measure engaged in attempting to remove the reasons for its existence. As the feeling for justice and equity grows and the social conscience gains in strength, the law is freed to take up new and larger questions. So when we come to the province of medicine there opens before us a new order of things, arising from our progress in the control and elimination of disease.

The prevention of many important forms of disease has been carried far, but that is only the first step. This condition must be maintained. Here, as elsewhere, eternal vigilance applies. Moreover, new conquests in this field are yet to be made and much devoted labor and keen thinking are needed to that end. This brings the physician more and more into the service of the community at large.

It is in this connection, however, that we find a depressing maladjustment between the community and the physician. All will admit that he who does good to the many is certainly entitled to as definite reward as is the man who benefits a single person. Surely that proposition needs no arguments in its support. Nevertheless, to put the case quite mildly, as matters stand, the man dealing with the single patient is usually the more certain of his remuneration and the more directly recognized. Yet of the two his service is the less.

A fair adjustment of this defect in our social dealings has not yet been found—though certainly it will be. Despite this drawback, however, it can not fail to be a great encouragement for all of us to observe that those working for the public interest and the general good are many and industrious—too occupied with fruitful studies to make much talk about their own misfortunes.

You can not fail to have noted that the progress I have mentioned has been largely in connection with those forms of disease which are due to pathogenic organisms. With these we may contrast the great group in which increasing age and functional misuse and strain seem to be the more prominent factors.

Advances in this field might be noted too, but, passing over these, emphasis is to be laid on the fact that for the proper understanding and control of such diseases one is always seeking help from chemistry—organic, physiologic, biologic, as the case may be. To be sure, the use of chemical ideas by physicians is almost as old as medicine itself, yet the call for such ideas has never been so urgent as to-day, and this call taxes a portion of medical training which, in the past at least, was under-emphasized. It amounts almost to a sudden rearrangement of medical demands, for the commoner ailments, only slowly to be reduced by the gradual enlightenment of the laity, tend to become more and more those which must be met through the control of nutrition and other modifications of our daily life.

Of course when a period of rapid change like that at present in progress occurs in any profession or occupation, there is always created a really tragic situation by reason of the fact that some among the older men have not been taught and can not learn the newer ways, and thus inevitably suffer disadvantage. For them the new ways are bad—and for them the times are out of joint. Naturally the capacity to progress is a highly variable gift, but many instances go to show that it is often thought to be exhausted where there is still much remaining in reserve.

In his discussion of the energies of men, William James has pointed out some possibilities in this direction which both cheer and stimulate. To advance this way sometimes calls for the preliminary removal of worn-out mental furniture. Few of us have escaped some forms of undesirable instruction—we have been given details in place of principles, aid instead of exercise, views as substitutes for demonstrations—and thus in respect to some sorts of knowledge it is as important to know how to let it go as in other cases to know how to grasp the parts worth while. Thus the aim of the progressive man must be to see life steadily and see it whole—prepared to change when change is growth, unwitting of fatigue, and never a worshiper at the shrine of his own past efforts, no matter how strenuous these may have been. Much more might be said upon this topic of the new demands and the adjustment for which they call, but if enough has been given to make you see that a serious problem lies that way my purpose is accomplished.

The moment has now come, as it does to every speaker, to wonder whether success has followed his attempt to reveal what he had in mind. What I have wanted to show you was this: The attitude towards knowledge during our student days is almost necessarily such as to throw the idea of change into the background and unduly to emphasize the permanency of the things then taught. The facts are otherwise.

Change has always been—will always be—and in the near future progress will be more rapid even than to-day. It is to this main fact that I urge you to adjust, for which I encourage you to prepare. The progress with which you have to blend your lives comes from work at the bedside, in the hospitals and in the laboratories and is also a by-product from advances in fields often seemingly remote from medicine.

Moreover, social advances, the growth in the attitude of the community at large—which slowly alters like the form of a great cloud—presents an ever-changing background for the activities of the physician. Two important consequences of this touch you as medical men.

To succeed in truth, you must be prepared continually to replace old knowledge by new and to alter old economic methods and customs to meet the disappearance of some familiar forms of disease and their replacement in your life by newer medical problems and demands often of a general and a public nature.

To the generation of physicians to which you belong this task is allotted and it calls for the best you have to give. Surely the devotion to human welfare can not be less strong with you than with your noble predecessors and no hampering self-interest should be allowed to obscure from you the larger purposes of science and the sacred responsibilities of your profession.

Finally, it is through you that the layman learns of medical progress and its meaning, it is to you that he brings his questions and his doubts concerning methods of experiment and modes of inquiry needful for the advancement of your science, and both your appreciation and support of research in medicine are necessary to keep the public so informed that its representatives and lawgivers shall understand the purposes of this work and grant to it intelligent support.

HENRY H. DONALDSON

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

A NATIONAL UNIVERSITY BASED ON NATIONAL IDEALS[1]

BEFORE such a learned organization it is not necessary to dwell on the development of the modern university from its ancestral

[1] Address before the Section of Education at the Cleveland meeting of the American Association for the Advancement of Science.

prototype established by Abelard in Paris. By its very nature a university is the most conservative of organizations and its dominance over the thought of a people and all minor forms of education has been always acknowledged. The challenge to this right has always arisen outside its walls and influence, and such challenge has taken the form of many kinds of technical institutions to meet specific needs of the community forming their organization.

Neither is it necessary for me to point out to this audience how the idea of a specially favored educated class has always prevailed, and probably must always continue to a great extent. It was not, however, till our people grew up to independence on the basis that all men are created equal that the free public school became the corner-stone of our national life. Our material success as a nation is largely attributed to the splendid system of common schools and we congratulate ourselves that they are the best in the world. This national pride is flattered by the supposed acknowledgment of their superiority as evidenced by the visiting boards of inspection that come here occasionally from foreign countries. There seems, however, to be no fear that self-complacency will lull us into inaction, for we are a progressive people, and are well aware that institutions which are too tightly bound by fixed methods inevitably begin to die. Everywhere we are alive to our shortcomings, and great as our educational system is, nevertheless we are ever aware that somewhere, somehow, things are not altogether right.

It is safe to say that education is both an economic and a social question. Let us now consider them both. So long as the laws limit citizenship to those who have attained twenty-one years of age, is it wise economy to allow the youth of our land to leave school at the age of fourteen or fifteen? Physically, mentally, morally and spiritually they are only partly developed, and yet our boasted system of education loses its hold on 80 to 90 per cent. or from eight to ten millions of our youthful population. The recent exhibition in Washington of the International Congress of Hygiene and Demography showed one phase of the result of such neglect of our youth, and as we have printed a bulletin on its relations to the university, copies of which are here for distribution, I will not now dwell on these arguments, but simply state that the sum total of the scientific research into vital statistics goes to show that crime and disease and degeneration are increasing more rapidly than the increase of the population; that genetically we are not breeding most from the best types of humanity but from the weaker ones. I ventured to point out that, as the school system fails to hold the children between the ages of fourteen and twenty-one, we are losing the most potent years for the development of character; that the real salvation of man is through work, self-respecting, self-sustaining toil and the opportunity to obtain happiness through intellectual and spiritual growth. Now let us return to the thread of our argument.

Inasmuch as over 80 per cent. of the youth leave the halls of learning so young, the conclusion is inevitable that the reason is because the education furnished, after that age, is not sufficiently in accord with the needs of the people. Either there is lack of appreciation of the value of additional academic education or else the mere cost of maintaining the child is too much of a burden on the family purse. Since by far the larger majority of the children are forced by circumstance or voluntarily leave school to earn a living, is it not self-evident that 80 per cent. of all public funds ex-

pended for public education above the grammar grade should be for vocational education? Not only so, but that such further public education should be for workers and home makers in the productive industries.

If you turn to the experience of the world you will find that the age of budding manhood has always been the age of apprenticeship. How can such a system of apprenticeship be established except by a close contact with the simplest forms of industrial life, developing each vocation as a natural sequence from the simple and fundamental to the complex and abstruse? In order to be explicit suppose we define the vocations as of two classes, the minor arts of expression or those which pertain to the care, development and maintenance of the body, and then the major arts of expression or those which pertain to the care, maintenance and development of the mind and the spirit. These two kinds of expression are so interlaced and interdependent that they can not be separated, and since also we are providing a university for a selected part of the eighty-odd per cent. of the youth of the land who now have no means of attaining a full development of their native ability we must consider the two as virtually one problem.

The first duty of such an educational system is to make each student self-supporting as soon as may be through the minor arts of expression or the care and development of the body. This must necessarily begin with tilling the soil and following the industrial trades that contribute to husbandry, which, of course, includes almost everything. This implies that the university and its subsidiary branches must be in control of a large quantity of land on which to demonstrate the application of all the arts and sciences to daily life. Not on the commercial basis of making the student have the maximum of efficiency in the production of wealth for the sake of profit and gain alone, but also in all the major arts of expression which contribute to the intellectual and spiritual enjoyment of life—in plain words, to know how to live for the real things which make life worth while. To put it more bluntly, our present public school system will always fail of its final purpose unless it can develop the best there is in every one of our nation's children, and this can be done only by making it a possibility for any one, with the ability and the will, to make his own way through an industrial university established on the American ideal that every one should have a fair chance in the race of life—a chance to be self-supporting, self-reliant and have an all-round physical, moral, spiritual and industrial education up to the period of manhood, instead of being turned loose on the world while still children, as is now the custom.

Everything is ready for such a university. We have all the minor forms of the arts of expression already well established in state industrial schools, agricultural colleges and experiment stations. It is only necessary to establish at some central position, like the national capital, a great university with abundance of acreage to demonstrate the infinite possibilities of the minor arts and also the major arts of expression such as music, poetry, the drama, painting, sculpture and architecture, and devoted to the advancement of science. Our great new country with its marvelous natural, undeveloped resources has of course demanded the development of the people in the minor arts of expression first. After we have measured the greatness of a nation in its material resources and attainments, it remains to inquire what they have done in the realm of the major arts

of expression. It is only in the application and use of these major arts to the daily life of all the people that we can as a nation attain our inalienable rights to life, liberty and the pursuit of happiness—happiness that is spiritual and not merely physical. It is the lack of this intellectual and spiritual resource within ourselves that is the cause of so much discontent and misery among our people. Depriving the youth of the land of these higher things of life is robbing them of their birthright as citizens of this great republic. Therefore such a national university devoted to these higher aspirations of the soul is just as much a national need and a national duty as the primary school, and without which our educational pyramid has no apex.

Such a university in no way competes with or interferes with those state and denominational institutions which already exist, but by cooperating with them and supplementing the work they are doing it will bring all our educational forces into one harmonious whole and ever provide them leaders and teachers along new lines. By the establishment of local university centers wherever the present educational forces are inadequate for the needs of the people, it will be taking higher education to the people in a way that could never have been done before. We have at present an abundance of education for the rich and well-to-do; let us have in this new university an abundance of education for those who have to win their own way and are willing to give some share of their own services to the nation in part compensation for the advantages which the nation gives them through such an institution of learning. Let it be an institution where high pressure and haste are not the dominating influences, but one where thoroughness and devoted service may be an essential element. It is not necessary to force all wisdom through the human mind in a four years' course. Study and research should be the constant companion through life and a distinct gain will result in having one university wherein there is always contact with active production, and application of the arts and sciences to the life of the people. Another distinct gain will be in the holding in one institution the interlocking minor and major arts of expression just as they are in life, instead of having them separated as at present in various institutions. By this means we would teach that it is just as honorable to make a beautiful and useful basket or chair as to paint a picture or finance a railroad. The quality of excellence, honesty and utility applies to one as much as to another. We are not all qualified for the same work, and the influence of such a university would be to make it more easy for every one to find that occupation for which his natural gifts qualify him to attain success.

Our present scheme of education is to keep the student in an uncertain frame of mind as to his future work for as long a time as possible in the hope that the broad general education attained under such influence will enable him to choose a vocation more wisely. This may be true in a very, very, few instances but it usually has just the opposite effect of scattering the attention and inclinations while limiting at the same time the horizon line, on account of the very few professional courses provided. The policy of most universities seems to be to fence themselves in and make it ever more difficult for the student to enter on the plea that they are raising the standard of the scholarship. If a Phidias, a Raphael, a Mozart, a Galileo, a Shakespeare, a Tessler or a Hirschel, should ask admission to a modern university by reason of his ability, he would be examined in cube root, conic sections, ancient and modern history, and

required to analyze and parse Spencer's "Faerie Queene." The basis of examination is of analysis and criticism and not of construction and production. In all other things we are a practical people and our national university should broaden the lines of approach to higher education and make it possible to attain success in all the walks of life. Especially do we need an institution for constructive and vocational education in the major arts of expression. Only by a definite technical training in them from an early age, coupled with a broad general education, can we hope to attain great things in music, poetry, painting, sculpture and architecture.

The Department of Agriculture has had no great difficulty in building up a great system of scientific experiment and distribution of knowledge in everything which pertains to life on the farm, on the plea that all wealth comes from the soil, yet only one third of our population gain their living by tilling the soil. We ask of this new national university that it shall give an equal chance to the remaining two thirds of its citizens. We ask for the eighty-odd per cent. of our children the privilege of using the seven most important years of their childhood for their own development in an institution of learning where they may utilize their own earning capacities for their own growth.

This new university should recognize that every youth has the inalienable right to such instruction as will develop all the best there is in him, and this can be done best by making him self-supporting and self-reliant until he can take his place at maturity fully equipped for the battle of life. This is not to be attained by pampering and protection, but by tempered hardship and strenuous voluntary effort. Youth naturally seeks these environments and because our schools and colleges do not furnish them for those who need them most, such an institution is not only an economic necessity but a moral necessity—if we are to rise to our national ideal that all men are created free and equal. Free to make the most of life and equal in the opportunities for self-development.

The government, early in its life, established schools for the Army and Navy on the necessity of national defence. Any national university must obviously give place to training for the civil service and the consular and the diplomatic service. For these reasons, if no other, the university and its subsidiary branches should give degrees or diplomas that will answer for civil service examinations in the many grades of this occupation. This kind of training is so varied and frequently so technical that no existing institution could be expected to do it for the government.

Of course, the great central university devoted to the highest kind of research in science, arts and letters, should reserve to itself the higher degrees, and that the attainment of such high degrees should be of such a kind as to have national and international importance.

Every great movement for the salvation of man from the sloth of degeneration has taken the form of exalting the people's ideals into a religion. Under such influence the world has tried salvation by faith, salvation by creed, salvation by vicarious atonement, salvation by law. Each age has also built great temples to their ideals to give definite form and power to their aspirations. If we are true to our national ideals of liberty we will build a temple to liberty in every county and city ward, where we may enthrone science and art and liberty for the salvation of mankind. During the centuries past the world has bowed before the privileges gained by force of arms, privileges granted by royal favor,

privileges gained by wealth. It remains for the American people to establish, by means of their ideals and temples to Liberty, the nobility of character as expressed by service to the welfare of all, through the realization of the brotherhood of man.

> "I ask not wealth, but power to take
> And use the things I have aright,
> Not years, but wisdom, that shall make
> My life a profit and delight.
>
> "I ask not that for me the plan
> Of good and ill be set aside,
> But that the common lot of man
> Be nobly borne and glorified."

H. K. Bush-Brown

THE SCIENTIFIC STUDY OF THE COLLEGE STUDENT[1]

It is worthy of note that, while the critics of the college have been able to adduce facts as the basis of their unfriendly opinions, the colleges have, for the most part, been unable to point to any considerable collection of accurate data regarding their own present effectiveness. It is, of course, quite true that the deductions drawn from their facts by these unfavorable critics are oftentimes manifestly more imposing than the factual structure can properly stand. It is also true that along certain detached and scattering lines this college or that has been able to point with pride to a small amount of accurate material more or less scientifically collected. Speaking broadly, however, the statement first made is true. It is perhaps to be acknowledged that the introduction of the larger use of facts into the measurement and development of college values will make education somewhat less interesting, for it will reduce the range of philosophical discussion and the application of personal opinion. Still, if the signs of the times are at all to be believed, the day is fast approaching when the colleges and universities will be using facts and the scientific method as much in the direction of their educative processes, as a whole, as they already are using them in their laboratories and classrooms.

[1] Address before the Section of Education at the Cleveland meeting of the American Association for the Advancement of Science.

Secretary Furst, of the Carnegie Foundation, has said that there should be little talk of efficiency in college work until something has been done to make use of the enormous collection of data already possessed by the colleges of the country in the records of the hundreds of thousands of students who have passed through the four years of the campus and into the work of the world. Certainly there does exist a large body of facts worthy of study in connection with the administration of the present-day college. It seems to me rather doubtful, however, whether these facts are as likely to be given the attention they deserve as those collected according to some new method and with closer reference to the various problems to be solved in connection with the present and the future generations of students.

If this question is to be answered in the affirmative, it raises another. Shall the information for measuring the effectiveness of the college work with the present generation be attacked piece-meal—one problem one year, another the next, one phase in one college, another phase in another—or shall each college endeavor to conduct a study that shall be for it at once fundamental, broad, permanent and, in addition, as nearly scientific as the twentieth century permits?

A study possessing these dimensions has already been proposed by one of the greatest educators America has ever known. In 1899, President Harper, of Chicago University, recommended what he called the "scientific study of the student." Said that educational path-finder:

This study[2] will be made (1) with special reference to the student's character—to find out whether he is responsible, or careless, or shiftless, or perhaps vicious; (2) with special reference likewise to his intellectual capacity—to discover whether he is unusually able, or bright, or average, or slow, or dull; (3) with reference to his special intellectual characteristics—to learn whether he is independent and original, or one who works largely along routine lines; whether his logical sense is keen, or average, or dull; whether his ideas are flexible, or easily diverted, or rigid; whether he has control of his mind, or is given to mind-wandering, and to what extent he has power to overcome difficulties; (4) with reference to his special capacities and tastes—to determine whether these are evenly balanced, or whether there exists a marked preference for some special subject; whether he prefers those aspects of study which are of the book type, or those of a mechanical or constructive type, or those of a laboratory type; whether his special gift lies along lines of an esthetic character, or those of a literary or scientific or philosophical character; whether his special aptitude, supposing it to be in the literary field, lies in criticism, or interpretation, or creative work; whether his preference in scientific lines is for the observational or the experimental side of work, or for general principles; and, finally (5) with reference to the social side of his nature—to judge whether he is fond of companionship; whether he is a leader or a follower among his fellows; whether he is a man of affairs, or devotes himself exclusively to his studies; the character of his recreation; the way in which he spends his leisure hours; whether he is compelled to work for self-support, or for the support of others.

These details, among others, will be secured in various ways; in part from preparatory teachers, in part from parents, in part from the student himself, in part also from careful observation of his work in the first months of his college life. It will be no easy task; but the difficulties will not be greater than its importance.

Such a diagnosis would serve as the basis for the selection of studies; it will be of paramount value in determining the character of the instructor under whom he should study; it will also determine the character of all advice given the student and of any punishment administered; likewise, it will determine in large measure the career of the student—will help him to find himself and decide upon his life-work.

[2] "The Trend in Higher Education," pp. 321–325.

The object of this paper is to recommend in detail the plan thus proposed. It is urged not as possessing the virtue of a dynamic in itself, but simply as a testing of the personal dynamics of the college to effect the purposes for which it was established in the hope of making practicable a wiser direction of those personal dynamics.

First of all, the college will need, in order to determine its effectiveness, will it not? to discover the position of the student at the moment of the beginning of his course. In order to accomplish this, it will wish to send out to the student's teachers in the secondary schools a blank asking for much other informaton than that at present desired. This other information would cover, as far as found practicable, the mental, moral and temperamental characteristics of the student, though in a less detailed manner than that suggested in the blank to be exhibited. Inquiry could also wisely be made regarding the educational and moral advantages of the student's parents and family, as well as the family's social, and perhaps also its economic, status.

At the same time a blank of a more intimate sort could be submitted to the parents, and also, in the case of a small town, to the local minister or the librarian, asking information regarding the personal characteristics of the student in question—whether, for instance, he is ambitious, energetic, serious-minded, truthful, of a plodding or intuitive mind, possessing marked self-control, etc. In the cities the obtaining of such information might conceivably be difficult; in the small towns, however, there is a wealth of personal interest in the chosen few who go to college which will be happy to make itself useful the moment colleges become organized to take advantage of it.[3] The smaller towns and cities,

[3] At the University of California facts of the kind suggested are obtained in order to facilitate the assignment of the proper advisory officer.

also, will admit of study as to their educational and moral characteristics by the officers charged with the recruiting of students—a study which will be found of financial as well as educational value.

To a student's rating as thus obtained from his friends would be added that obtained from the student himself at the time of entrance regarding such matters as purpose in attending college and strongest influence thereto, aim in life, favorite books, chief historical admirations, etc., as well as by a series of tests. Doubtless some adaptation of the Binet and other tests such as those of Professor Thorndike could be arranged by the department of psychology which would give in more or less approximate form the student's mental status and characteristics. To this there could very wisely be added by the same department the testing of the student's range of information by means of Professor Whipple's list of key words. With very little modification and extension, also, the present physiological examination could be made to include certain simple tests for the time and form of reaction to tactile and other sensations and perceptions—*e. g.*, color, form, sound, etc.

These tests, when assembled, would serve as an indication of the starting point for the agencies of the higher educative processes. Reference to this starting place would at least make more definite and exact the controversy with the unfriendly critics of higher education who assert that nothing definite can be claimed by the college, simply for the reason that its human material is so selected that a large proportion of the effectiveness of its graduates is due to that selection rather than to its institutional efficiency.

With the starting point thus determined, the measurement of the effectiveness of the college's activities becomes more serious as well as more active. Toward this end, also, there can be used a body of persons whose judgment should be better trained for the work than those consulted in connection with the other preliminary measurements suggested. It can surely not be too much to ask that every teacher should be asked by the administration to fill in for each student a blank submitted to him in some such form as the accompanying card. I have had the courage to outline such a card simply for the reason that at this point the whole question of the feasibility of the proposed scientific study of the college seems to me to hinge less upon the matter of psychology than of mechanism. In the minds of many authorities who have been consulted, that is, the practicability of the plan depends not so much upon its worthiness as upon its ability to secure the cooperation of the teacher, in competition with the other interests seeking his attention. Perhaps this will be accomplished all the better, accordingly, if the description of the student as called for by the card is not made of such a nature as to appeal only to the psychologist. At any rate, the plan is, apparently, likely to prove of practical value in proportion as it avoids the necessity for extra mechanical work at the hands of the teacher, who is very properly expected to be more interested in other things than the writing of needless words upon a card. You will notice, therefore, that our proposed blank is supposed to go to the teacher with the student's name, classification and other details above the double line already written upon it before it leaves the administrative office.[4] You will notice, further, that the card submitted—as also the other questionnaires recommended—is supposed to be filled out almost entirely

[4] It should be true of every one of the blanks used that persons asked to fill them should not be required to write a single word which the administrative office is in a position to write itself.

by the use of checks (∠), these checks to be supplemented by one or two general phrases under the caption "Remarks." A very little study by the administrative officer will detect plenty of ways by which they can save for the teachers enough time to offset the demand made by these cards.

In order, at the same time, to facilitate its own operations, the administrative office will plan to prepare, at one writing, with the help of a manifolding machine, the blanks required by all the different teachers during one year for each student, inserting separately only the study-classification, *e. g.*, "Soc. 17." On receiving them back from the teachers they can be assembled in folders and their material collated upon sheets—prepared also at one writing—for the use of the departmental dean, the disciplinary dean and the other advisory officers. On this sheet there should also be room for indicating the reports of the various entrance tests, in addition to the grades reported by the registrar or the secretary, and in addition, further, to the student's record in various student activities as reported by the officer charged with that responsibility. Every dean and advisory officer of any kind would, accordingly, have in his possession a complete showing of the student's whole life in college as well as the rating of a more general sort given him by his secondary teacher and his home friends, together with the more scientific rating resulting from the test on entrance. As his course advanced, more and more of this material should be shown on the upper parts of the blanks submitted to the teacher.

The advice and the whole range of attention given the student, therefore, at any time would be based upon this survey of his whole personality. Undoubtedly the attention given him by the various advisory officers would be immensely more valuable than is conceivable under the recent and present method of parcelling out a limited number of students to a number of teachers in the vain hope that an occasional quarter-hour or half-hour of conversation will serve to put the teacher in the position of an expert for the direction of the student's present activities and future career.

Is it going too far to take seriously President Harper's belief that "such a diagnosis would serve as a basis for the selection of studies"? Is it not conceivable that, at least to some extent, in the recommendation of studies, the advisers could have in mind the correction of the defects shown on the collated report? If, for instance, all reports indicate that a certain student possesses an able mind but refuses to use it carefully, is what might be called a disorderly thinker simply from pure mental laziness, could the adviser not wisely emphasize the value of mathematics or certain other of the exact sciences? Similarly, for the student who is a plodder, taking each step conscientiously at a time, but lacking the imagination with which to take a half or a whole flight of mental stairs at a leap, could not a good teacher of history, economics or other study calling for broad grasp and ability to generalize be recommended very strongly, if not with compelling power?

In that event each teacher could legitimately be expected to have in mind these uses of his teaching of a subject in addition to its usual informational or disciplinary values. Or, if that seem unfeasible, the teacher might be asked to bear in mind in connection with each member of his classes the particular mental aspect shown by the cards received from the administration office to be of greatest interest or of greatest need on the part of that student.

Whether such a use in the selection of studies is possible or not, there can be no

doubt that the diagnosis would be found tremendously helpful—indeed absolutely necessary—to that newest officer in the college world—I mean the vocational adviser. If he is to make himself genuinely useful to the student he will find it essential to possess himself of many more facts than can be obtained in any number of conferences with the student. It will be noticed, I venture to prophesy, that the vocational adviser, within six months after his election, will raise a cry for facts that will not be stilled until every part of the whole educational system—including the secondary schools—is busy handing them in perhaps in much the way here proposed. It is, as a matter of fact, significant that one of the few institutions in the country that have already been using a system comparable to this, is a school where the claim of the vocation is strong, the Massachusetts Institute of Technology. There, in addition to the gathering of detailed facts regarding every student, at the hands of his instructors, a stenographer is present at every faculty meeting where names of students are mentioned to record any remark made about them. Everything ever said or written concerning a student is gathered together for the use of the officer in charge of the placing of graduates. As a result of this the dean of the institute has assured the writer that the officers have enjoyed a remarkable success in fitting their graduates into positions making unique requirements. Doubtless for the same reason an approximation of the same plan has recently been proposed for the adoption of the Springfield Y. M. C. A. Training School by the committee charged with the responsibility of testing and increasing the effectiveness of that institution.

Further there will be added to the facts already collected the showing of the intellectual and general status of the student at graduation. These tests can be chosen from, and related to, those made of the entering freshman in whatever proportion and extent seems desirable. Undoubtedly, the application of Professor Whipple's "information range finder" would be particularly significant. If the student shows a much greater familiarity with such terms as "southpaw" or "snapback" than with "cytology" or "Pythagoras," it may be held to indicate that the realm of athletics had been more suggestive than that of science or philosophy. In any event, the tests chosen should serve as an approximate measurement of the advance made in scholarship, mentality, character, temperament and social qualities within the four years of the college.

Only an approximation, of course. The real value of the years could only be shown after the secretary in charge of alumni relations had made it his business to secure in legitimate and effective ways some general measurement of the effectiveness of the former student as a person and a citizen. It is quite likely that the next college officer to follow the vocational adviser will be such a secretary for alumni relations, charged with the very serious and statesmanlike responsibility of making the college mean as much as possible to the graduate and the graduate to the college. Possibly the vocational adviser would himself be this officer, traveling part of the year in order to consult with commercial, professional and other leaders, with successful graduates and with unsuccessful ones—all for determining in what ways the college stands in need of improvement as a developer of abilities, interests and viewpoints required for the meeting of the needs of the world.

When the report of such an officer has been turned in and put alongside the material already mentioned, then the college

will have the right to feel that it is conducting a study sufficiently scientific, serious and fundamental to be worthy of the seriousness and importance of its educational responsibilities. Then and only then will it possess a body of facts from which it can gain genuine light with regard to such problems as the following:

I. The relation between (*a*) the college course and "success in life" (however defined), (*b*) between scholarship and success, (*c*) between particular fields of study and success, etc. II. The extent to which the college course modifies the student's (1) character, (2) intellectual capacities and characteristics, (3) social and (4) moral nature, (5) life plans; with (6) the general direction of such modifications. III. The extent to which (*a*) it extends the fields of interest and information brought to college, and (*b*) adds new fields. IV. The approximate comparative importance as factors in these modifications of (*a*) teachers, (*b*) subjects, (*c*) student activities, (*d*) companions, etc. V. In comparison with the college, the influence on scholarship in college and on success in life of such elements of the home and preparatory environment, as (*a*) social, economic and educational status of parents (including the size of the family), (*b*) the geographical location, size and chief characteristics of the home town or city—especially in its general educational and moral agencies, also (*c*) the educational standards and methods of the secondary school.

Only then will every month and every year and every person connected in any way with the educative processes be made to contribute its proper quota to the wisdom which the present should receive from the past and the future demands of the present, a quota of which our educational generation has been cheated by an unorganized and unscientific past.

Only then, also—and it is to be considered one of the most important products, if only a by-product of the whole plan—will there be an organized way for making evident the distinction between the college and the university teacher. For if the blanks coming from any one teacher are found invariably to indicate a complete lack of interest in, and just judgment of, the pupil, it will indicate that, so far as the college is concerned, that teacher has probably not sufficient human interest to be worthy of his collegiate responsibility, though he may be entirely worthy of the work of interpreting his field within the less broad and general channels of the university.[5]

Who will attempt to estimate the value of a five-year study along the line suggested as conducted by a number of institutions, to say nothing of its value if conducted simply by one institution? Since President Harper proposed the plan, the world has made an amazing advance in the adoption of the scientific method. After all, the scientific method is nothing more or less than the collecting of facts and their use in the accomplishment of desired ends. In this use the facts are proved as well as taken advantage of. The period in which we live, as the result of the spread of this scientific method, may well be called the "pragmatic period"—owing allegiance, that is, not so much to the reign of law as to the reign of results. No one believes that the college is going to be found permanently unable to adapt itself not only to life, but to development and growth in such a period. But this means that it is

[5] "The college is the place for the student to study himself—and for the instructor to study each student and to point out his weak and his strong points. . . . The university is for men who have come to know themselves . . . to study in the line of their chosen calling." President Harper, "Trend in Higher Education," p. 324.

only a question of time until the college discovers its delinquency in having failed to observe that, while it, more than almost any other institution known, is charged with the development of broad human values, it is doing less to study these values and the means of their development in a broad, yet scientific, manner than are many commercial institutions not supposed to be at all concerned with human factors.

Can we not here to-day among ourselves "highly resolve" that President Harper shall not have lived and shall not have spoken in vain when he said regarding the plan thus described to you, "This feature of twentieth-century college education will come to be regarded as of greatest importance, and fifty years hence"—shall we not make it fifteen?—"will prevail as widely as it is now lacking. It is the next step in the evolution of the principle of individualism, and its application will, in due time, introduce order and system into our educational work where now only chaos is to be found."

CHARLES WHITING WILLIAMS
OBERLIN COLLEGE

THE AMERICAN MINE SAFETY ASSOCIATION

THE annual meeting of the American Mine Safety Association composed of leading coal and metal mine operators, mining engineers, mine-safety engineers, and mine surgeons will be held in Pittsburgh, Pa., September 22–24.

This association, which held its first meeting a year ago, has for its purpose a reduction of the number of accidents in the mines and quarries (3,602 in the year 1911) and the alleviation of the more than 60,000 men who are injured each year.

Following the recommendations of the Bureau of Mines in the last three or four years many mining companies have organized rescue corps and first-aid teams, and as a result a number of different methods of procedure following mine explosions and fires and in the caring for the injured have developed. The men who gathered a year ago to form this association felt there was great need for greater uniformity in the work of the rescue and first-aid crews and at that time some very important recommendations were made.

This second meeting, which has been called by Mr. H. M. Wilson, of the Bureau of Mines, chairman of the executive committee of the association, promises to take up and discuss a number of the problems that have arisen in both the rescue and first-aid work. The members of the association declare that greater progress can be made in saving life and in reducing the seriousness of injuries by the adoption of the proposed standard methods.

The program will include a mine-rescue and first-aid contest at Arsenal Park on September 22; in the evening a reception to the members and motion-picture lecture on the mining industry. On the second day the opening session of the association will be held in the morning and a report of the executive committee will be made on the proposed constitution of the society. In the afternoon there will be an explosion in the experimental mine of the Bureau of Mines at Bruceton, Pa., to which all the members will be invited to be present. On September 24, the third day, there will be a business session at the hotel and a selection of officers. In the afternoon members will visit the experiment station of the Bureau of Mines at 40th and Butler Sts., Pittsburgh, Pa.

THE CROCKER LAND EXPEDITION

THE Crocker Land Expedition (George Borup Memorial) sailed from the Brooklyn Navy Yard, New York, in the Newfoundland steam sealer *Diana*, on July 2, with the major portion of its equipment aboard. The ship called at Boston for 13,000 pounds of pemmican and other stores and sailed for Sydney, N. S., on July 6. Sydney was reached in the morning of the 9th, and there 40,000 pounds of dog biscuit, 13,000 feet of lumber, 40 pairs of snow shoes and 335 tons of coal were taken aboard. The *Diana* left Sydney on the 13th loaded to the rails, but she had yet to call at Battle Harbor, Labrador, to take up the 30-foot power

boat *George Borup,* which has been in storage there all winter, and twenty Eskimo dogs and an interpreter. The party was to leave Battle Harbor on Thursday, July 17, headed for the west coast of Greenland. A stop may be made at Disco, West Greenland, for the purpose of setting observation stakes in the glacier there, but the first real objective point is Cape York, where the walrus and seal hunting will begin.

It is probable that much of the cargo will be landed at Payer Harbor, Pim Island, but the main headquarters of the expedition are to be established at Flagler Bay on the south side of Bache Peninsula.

The Crocker Land Expedition, which is sent out under the auspices of the American Museum of Natural History, the American Geographical Society and the University of Illinois, is probably the most thoroughly equipped scientific expedition which has been sent into the arctic regions from this country. Its scientific staff is as follows:

Donald B. MacMillan, A.B., A.M., F.R.G.S., leader and anthropologist;
W. Elmer Ekblaw, A.B., A.M., geologist and botanist;
Fitzhugh Green, U.S.N., engineer and physicist;
Maurice C. Tanquary, A.B., A.M., Ph.D., zoologist;
Harrison J. Hunt, A.B., M.D., surgeon and bacteriologist.

In addition to these there are: Jerome L. Allen, detailed by the United States Navy Department for service as wireless operator and electrician; Jonathan C. Small, mechanic and cook; while Edwin S. Brooke, Jr., is on the ship this summer as official photographer to the expedition.

It may be recalled that the objects of the Crocker Land Expedition are

1. To reach, map the coast line and explore Crocker Land, the mountainous tops of which were seen across the polar sea by Rear Admiral Peary in 1906.

2. To search for other lands in the unexplored region west and southwest of Axel Heiberg Land and north of the Parry Islands.

3. To penetrate into the interior of Greenland at its widest part, between the 77th and 78th parallels of north latitude, studying meteorological and glaciological conditions on the summit of the great ice cap.

4. To study the geology, geography, glaciology, meteorology, terrestrial magnetism, electrical phenomena, seismology, zoology (both vertebrate and invertebrate), botany, oceanography, ethnology and archeology throughout the extensive region which is to be traversed, all of it lying above the 77th parallel.

The installation of a powerful wireless telegraph station in connection with an arctic expedition is a new feature, by means of which, if all goes well, communication will be maintained with the party throughout their stay in the north. It is expected that daily weather reports will be sent from Flagler Bay to the Weather Bureau at Washington by way of government wireless stations in Canada which have been kindly placed by the Dominion authorities at the disposition of the expedition. News of important events in the history of the expedition and of important discoveries will likewise be sent promptly to the American Museum and the public at large.

The original program of work for the expedition contemplated two years or three summer seasons in the Arctic, but supplies have been taken north which will enable the party to remain three years or even longer if the results flowing from the work seem to justify the extension of time.

The mishap to the *Diana,* which went ashore at Barge Point, Labrador, since the above was written, may require the transfer of the equipment to another ship, but will not otherwise interfere with the expedition.

SCIENTIFIC NOTES AND NEWS

THE University of Edinburgh has conferred its doctorate of science on the Hon. James Wilson, lately U. S. Secretary of Agriculture.

AT Pekin University on June 16 the commencement address was given by Dr. Paul Monroe, professor of the history of education in Teachers College, Columbia University. Addresses were also made by Dr. W. A. P. Martin, vice-president of the board of managers, and the Hon. James Bryce. The degree of doctor of laws was conferred on Professor Monroe.

DR. A. PENCK, professor of geography at Berlin, has been elected a corresponding member of the Paris Academy of Sciences.

THE Royal Society of Edinburgh has awarded the Gunning Victoria Jubilee Prize for the quadrennial period 1908–12 to Professor J. Norman Collie, F.R.S., for his contributions to chemistry, including his work on neon and other rare gases.

DR. W. KILLING has for the second time been awarded the Lobachevski prize of the Physico-mathematical Society of Kasan.

SIR ARCHIBALD GEIKIE has been elected a trustee of the British Museum in succession to the late Lord Avebury. He was already an ex-officio trustee, as president of the Royal Society, but is now elected as a trustee for life.

THE senate of the University of London has conferred the title of emeritus professor of chemistry on Sir William Ramsay, who has occupied the chair of general and inorganic chemistry at University College since 1887.

ON July 23 an expedition for the study of marine biology, under the auspices of the Carnegie Institution of Washington, set sail from San Francisco for Thursday Island, Torres Straits, Queensland, Australia. The party consists of Dr. Alfred G. Mayer, director, and Professor Hubert Lyman Clark, D. H. Tennent, E. Newton Harvey, Frank M. Potts, of Cambridge University, and Mr. John Mills, engineer.

A CABLEGRAM from Peru to the Harvard Medical School indicates that the special expedition led by Dr. Richard P. Strong has made an exceedingly important discovery in establishing the difference between oroya fever and verruca Peruviana, a common and serious infectious disease. The party will return to this country in the fall. Their researches, besides those in Peru, have included investigations of the medical conditions in Guayaquil and the pest-ridden republic of Ecuador. Before their return they will study also the diseases in the countries of Central America and the regions of the Gulf of Mexico. Dr. Strong sailed from New York on April 30. In his party are Dr. E. E. Tyzzer, of the Harvard Medical School, and C. T. Brues, of the Bussey Institute.

DR. MAWSON has been informed by a wireless telegram that Sir Robert Lucas-Tooth has given a donation of £1,000 to the fund that Captain J. K. Davis is raising for the Australasian Antarctic Expedition. Captain Davis leaves England on July 18 for Australia. On his arrival there the *Aurora* will be refitted and will proceed to Commonwealth Bay to bring back Dr. Mawson and his six companions at present in the Antarctic.

THE National Geographic Society has made a grant to Professor Lawrence Martin to enable him to make detailed studies in September at Grand Pacific and Muir Glaciers. He will (*a*) measure the recession of several ice tongues in Glacier Bay, (*b*) look for advances of glaciers, (*c*) study the exhumed forests in relation to former glacial oscillations, and (*d*) make soundings in Canada's new harbor and other uncharted waters recently vacated by the glaciers, to see the effects of ice sculpture below sea-level.

FRANCIS CHURCH LINCOLN, professor of mining engineering in the University of Illinois, has resigned to accept the position of resident engineer for the Bolivian Development Company, La Paz, Bolivia.

DR. FRANCIS GOTCH, professor of physiology since 1895 at Oxford University, has died at the age of 60 years.

DR. EDUARD PECHUEL-LOESEHE, formerly professor in the University of Erlangen, known for his contributions to geography and for his explorations, has died at the age of seventy-two years.

DR. MAX DITTRICH, associate professor of chemistry at Heidelberg, has died at the age of forty-eight years.

DR. MAX KASSOWITZ, professor of diseases of children in the University of Vienna, has died at the age of seventy-one years.

THE U. S. Civil Service Commission announces an examination for editorial clerk, for men only, on August 6 and 7, 1913, to fill a vacancy in this position in the Geological

Survey, Washington, D. C., at a salary ranging from $1,500 to $1,800 a year. The appointee to this position should have such a knowledge of English, printing, and book-making, elementary geology, and geologic nomenclature as will fit him to criticize and correct, acceptably to their authors, the manuscripts of the survey's reports; to prepare them for printing; to carry along the work of proof-reading through all its stages, and to prepare satisfactory indexes to the reports.

THE Vienna Society for the Investigation and Prevention of Cancer has established a laboratory for experimental work on the subject, mainly in the domain of chemistry and chemical therapeutics. It is to be amalgamated with the Spiegler Institute, which has been in existence nine years. Professor S. Fraenkel has been appointed director.

DETAILS of the allocation by the Mansion House committee of the Scott Fund are given in *Nature*. The allocation falls under the three main headings of provision for the relatives of those lost (or, in one instance, incapacitated), for the publication of the scientific results and for memorials. The provision for the relatives includes £8,500 each for Lady Scott and Mrs. Wilson, £6,000 for Mrs. Scott and her daughters, £4,500 for Mrs. Bowers and her daughters and £3,500 in trust for the child Peter Scott, with smaller sums for Evans's family and to meet need in other two cases. One of the honorary secretaries of the Royal Geographical Society, Capt. H. G. Lyons, F.R.S., undertakes the editorship of the scientific results of the expedition, and representatives of that body and of the Royal Society, with Surgeon Atkinson, will control the work. A total sum of £17,500 provides, besides the cost of publication, for the services of three biologists, three geologists, two physicists, other specialists and a draughtsman, and the figure of £800 is earmarked for the production of charts and maps. For memorials, a tablet in St. Paul's Cathedral and a group of statuary in Hyde Park facing the Royal Geographical Society's house are proposed. A contribution to a memorial to Oates is being raised by his regiment as a special expression of regard for the memory of one whose relatives need no assistance from the fund. The published results of the expedition will not form its only scientific memorial; the establishment of a trust fund of some £10,000 for the endowment of future polar research will preserve the memory of the expedition, and would, in the belief of the committee, have commended itself greatly to its leader.

THE United States Bureau of Mines is about to investigate the conditions under which a miner works, believing that the unsanitary conditions which exist in some of the mines as well as in some of the mining towns are a factor in the death rate among the men. It is intimated that these conditions not only unnecessarily cause the death of miners through disease, but they are often responsible for accidents which might not have happened if the miners were in perfect health. The bureau has organized what is known as the Mine Sanitation Section, in charge of J. H. White, engineer. The bureau hopes to bring about progress by appealing to the miner, the manager and the owner, showing that all three can assist, and how all three can be benefited by good sanitary conditions. It will reach the miner by means of illustrated lectures, moving picture exhibits and pictorial circulars. These will show how sickness and suffering are spread by careless habits, and will drive home the importance of personal and household cleanliness. The bureau will assist the managers by pointing out glaring sanitary menaces, and showing methods and costs of abatement. It will describe in bulletins common unsanitary practises and show the evils which follow in their wake. It will submit sanitary rules and regulations and show the best methods for their enforcement.

AT the Minneapolis meeting of the American Medical Association the committee on awards, of which Professor W. T. Councilman

was chairman, made the following report, which was adopted:

In view of the general excellence of all the exhibits, your committee found great difficulty in deciding as to their relative merits. It wishes to recommend highly the exhibits as a whole and the very effective manner in which the demonstrations were made.

The committee has awarded the gold medal to Dr. C. C. Bass, of Tulane University, for the exhibit of the "Cultivation of Malarial Plasmodia in Vitro."

As exhibits to be distinguished by certificates of merit, the committee recommends the following:

"Cancer in Plants," Erwin F. Smith, United States Bureau of Plant Industry.

"Intestinal Parasitic Diseases," Lillian H. South, Kentucky State Board of Health.

"Histology of Goiter," L. B. Wilson, Mayo Clinic.

"Studies in the Physiology of Anesthesia," W. D. Gatch, Frank Mann and Dowell Gann, Indianapolis.

"Exhibit of Fetal Peritoneal Folds by Means of Specimen Photographs and Drawings," Joseph Rilus Eastman, Indiana University School of Medicine, Indianapolis.

"Blood-vessel Suturing and Transplantation of Blood-vessels and Intestines," J. S. Horsley, St. Elizabeth Hospital, Richmond, Va.

"Röntgen-ray Plates of Lesions of Various Internal Viscera," D. H. Carman, Mayo Clinic.

In the *Journal* of the American Medical Association there is some further information as to the International Medical Congress which will meet in London in August. In the section of the history of medicine a wide interpretation has been given to the subject. In some cases the papers will be more or less of an anthropologic nature. A paper on the history of the relations of medicine and vivisection is among these to be presented. That the artistic side of the subject will be well represented is shown by the following titles: "Relations between Art and the History of Medicine," Hollander; "Physiology of Vision and Impressionism in Art," Leonard Hill, and "Painting in Relation to the History of Medicine," Corsini. Sir Shirley Murphy has promised a paper on the origin and growth of public health legislation. Sir William Osler will give an illustrated lecture on the earliest printed medical books. Dr. Sambon will discuss the light thrown by the healing practises of animals and savage men on the study of primitive medicine. In the section of psychiatry, over which Sir James Crighton Browne will preside, Janet will discuss psychanalysis; Dr. Adolf Meyer will read a paper on the psychiatric clinic, its aims, educational and therapeutic, and the results obtained in the promotion of recovery. Dr. Morselli will discuss the psychology of crime. In the section of anatomy Dr. C. U. Ariens-Kapper, of Amsterdam, will read a paper on cerebral circulation and the precise function of the furrows of the brain. In the section of physiology there will be a debate on the correlation of the organs of internal secretions and their disturbances. In the section of pathology shock is one of the subjects to be discussed, and there is a special subsection devoted to chemical pathology. In the section of bacteriology and immunity, among the subjects to be discussed are theories of immunity and anaphylaxis, the nature of virulence, filter passers, leprosy and allied bacteria. In the section of therapeutics there are many novelties, such as nonbacterial toxins and antitoxins, the comparative value of heart remedies, and thermal treatment. In the section of surgery there will be a special subsection devoted to anesthesia, general and local, and recent methods, such as spinal analgesia, and there will be a discussion of recent special methods of general anesthesia. Professor Yandell Henderson, of New Haven, Conn., will contrast the immediate and aftereffects of spinal and local analgesia with inhalation anesthesia, particularly with regard to shock. Postoperative shock will also come under review. In the section of ophthalmology Professor Carl von Hess, of Würzburg, will read a paper on "Affections of the Eye produced by Undue Exposure to Light." In the section of hygiene and preventive medicine, the following subjects will be discussed: the effect of dust in producing diseases of the lungs, infant mortality in the first weeks of life, the factors that determine the rise, spread

and severity of epidemic diseases, the supervision of the health of children between infancy and school age, and the causes, prevention and treatment of visual defects in school children. In the section of naval and military medicine, the subjects are: hospital ships and transport of wounded, transport of wounded in hill warfare, water-supplies in the field, antityphoid inoculation, sanitary organization in the tropics, caisson disease and the physiology of physical training and marching. In the section of tropical medicine and hygiene the subjects to be discussed are plague, beriberi, leishmaniasis and relapsing fevers.

UNIVERSITY AND EDUCATIONAL NEWS

WASHINGTON AND JEFFERSON COLLEGE has closed a successful campaign for increased endowment, having raised the amount necessary to secure $100,000 promised by the General Education Board on condition that $400,000 be raised by the college. On June 30, the time limit set by the General Education Board, after an active campaign begun on April 15, last, with the Hon. Ernest F. Acheson as general manager, over $440,000 was reported. The entire sum thus added to the resources of the college may go to the general endowment fund, except $51,090 which represents the cost of the physics building, a notice of which was published in SCIENCE, June 27, 1913.

THE registration of students for the summer quarter at the University of Chicago shows a satisfactory increase over that of the last summer quarter, when more than three thousand students were enrolled. As usual, there is a large representation from the southern states.

ALL records for attendance at the summer session of Columbia University have been broken this year, the total number of students being 4,550, an increase of nearly 1,000 over last year, when the registration was 3,602. This is the fourteenth year of the session, which began in 1900 with 417 students. Since then there has been a steady increase in numbers, except in 1907, 1910, and this year, when the increase was much greater than the average. One of the reasons for the great increase in attendance this year is believed to be the improvements in the curriculum, especially in the courses in English. The classes here have been so large that it has been necessary to divide and subdivide them. Evening classes, a new thing this year, have also added to the popularity of the session, as have also the business classes. Besides this the entertainments provided are more numerous and varied than in any previous year. The attendance is almost as large as at the regular sessions of the university and the dormitories are almost as well filled.

THE government of India has refused to sanction the appointment of three professors in Calcutta University on the ground of their political connections. The senate of the university has passed a resolution objecting to this action and public meetings of protest have been held.

DR. GEORGE E. FELLOWS, formerly president of the University of Maine, succeeds Dr. Albert R. Taylor as president of James Millikin University, Decatur, Illinois.

DR. J. FRANK CORBETT, for thirteen years state bacteriologist of Minnesota, has resigned to devote his entire time to his work in the department of experimental surgery in the University of Minnesota School of Medicine.

DR. FRANK D. KERN, after nearly ten years as assistant and associate in botany to the Indiana Agricultural Experiment Station and part time instructor in Purdue University, has resigned to become professor of botany and botanist to the experiment station in the Pennsylvania State College. Dr. Kern has been a co-worker with Dr. J. C. Arthur in the taxonomic, cultural and other investigations of the rusts, and assisted in the preparation of part of the manuscript for the Uredinales in the "North American Flora," especially contributing the portion pertaining to the genus *Gymnosporangium*.

THE following announcements and appointments have been made at the University of North Carolina: President F. P. Venable has

been granted a year's leave of absence for travel and study abroad, and Dean E. K. Graham has been appointed to act in his stead; Professor M. H. Stacy, of the department of civil engineering, will act as dean of the college of liberal arts in place of Professor Graham; Robert L. James, C.E. (Cornell), has been appointed assistant professor of drawing; Parker H. Daggett, S.B. (Harvard), has been promoted from associate professor of electrical engineering to full professor in charge of the department; James M. Bell, Ph.D. (Cornell), formerly associate professor of physical chemistry, becomes full professor; W. L. Jeffries, A.M. (University of North Carolina), has been appointed instructor in chemistry.

Dr. P. G. Stiles, assistant professor of physiology at Simmons College, has been elected instructor in physiology in Harvard University.

Dr. Karl von Auwers, professor of chemistry at Greifswald, has accepted a call to Marburg, as successor to Professor Th. Zincke.

DISCUSSION AND CORRESPONDENCE

COLOR CORRELATION IN GARDEN BEANS

The note by Professor Hedrick on page 917 about the correlation of the color of the inside of the calyx cup and flesh of the peach is interesting. A similar correlation in garden beans has recently been observed at this station.

The blossom colors of many varieties of beans have been described as either white, light pink or pink, and most of the common varieties can readily be referred to one of these classes, though some varieties of the several classes may differ slightly among themselves in the depth and distribution of color.

There seem to be definite and constant correlations between these blossom colors and the color of the seed coat. A white or eyed bean is always white flowered unless possibly when the eye is very large. A white-flowered variety may have mottled or self-colored beans, but a genuine black pigment, such as seen in the black wax varieties, never accompanies a white or light pink, but always a pink flower. I do not recall any exception to this last. The bean may be pure black or mottled, with black appearing in the mottling, but in either case the flower is a pretty constant shade of pink. Sometimes a light pink flower may be associated with very dark colored seeds, yet their color is distinct from the genuine black of the black wax beans.

In general light pink flowers are associated with mottled or self-colored seeds of various shades of yellow, red and brown, but, as indicated above, never with a genuine black pigment, nor with white or eyed beans unless possibly when the eye is very large. It is probably due to the various seed coat colors that the flowers classed as light pink vary as much as they do among themselves; they are not as uniform as those classed as pink.

Just where the connection is between the blossom and seed coat color is not obvious but it is certain that there is some connection. Not only are the times of manifestation of the colors far apart, but there is no obvious resemblance between the colors. Why should a black bean arise from a pink or more exactly a purplish pink flower? Yet there must be some connection, and it would seem reasonable to believe that they arise from a common cause: that the plant possesses some pigment-producing substance capable of producing one color in the flower and an apparently entirely different color in the seed coat.

J. K. Shaw

Massachusetts Experiment Station,
Amherst, Mass.

A NEW METHOD FOR LABELING MICROSCOPIC SLIDES

It is very desirable that permanent microscopic mounts have permanent labels. Ordinary labels, even if of the best manufacture, are unsatisfactory, because the adhesive property of the glue becomes impaired with age. The so-called "Diamond Ink" which may be easily applied to glass, produces an etched surface which may be written upon and a permanent label obtained. This ink, however, is only sold by certain firms and as a consequence is not easily obtained.

this laboratory successfully is merely printing or writing the necessary description upon the slide with India ink. "Higgin's Waterproof (Black) India Ink," such as is sold at all book and stationery stores, is the ink used; a crow-quill drawing pen completes the outfit. The only necessary precaution to take in its application is to have the writing surface free from oily matter. This is removed simply by breathing on the slide and wiping briskly with a dry cloth.

The label so made is permanent as far as ordinary treatment is concerned. Xylol may be used freely to dissolve any cedar oil or balsam on the mount, with no injury whatever to the label; only a prolonged soaking in water would impair its permanence and such an occurrence would only be accidental.

This form of label has the advantage over that of the etched surface in that it may be as easily removed as applied; the whole label or portions may be changed by removing the unnecessary word, letters or figures with a penknife when the ink is thoroughly dry, or the whole label may be removed by rubbing off with a damp cloth. The India ink label because of its nature is more easily read than any other form of label.

A trial of this method will convince any one of its practical value.

ZAE NORTHRUP
MICHIGAN AGRICULTURAL COLLEGE,
EAST LANSING

THE METRIC SYSTEM

TO THE EDITOR OF SCIENCE: The attention of the writer was attracted to an article in a recent number of SCIENCE by A. H. Patterson, of Chapel Hill, N. C., in which he refers to the "wickedly brain-destroying piece of bondage under which we suffer" on account of the system of weights and measures in common use among the American people.

The only thing that the present system has to commend it to general use, if it has any redeeming quality at all, is that it is easier to follow along a beaten path than to make a change for the better.

The metric system is a simple, sensible, scientific and easily operated system of units and the best system that has ever been devised. That the metric system is practicable has been effectively demonstrated, for it is the universal system of scientific laboratories and it is high time that a strong public sentiment be created in favor of its general adoption. No doubt "a great part of the under-weight and false-measure frauds are due to our confused system of units."

It seems that the chief arguments against the adoption of the metric system are: first, the expense to manufacturers and commercial houses in connection with making the change; and second, the difficulty that would be encountered in educating the employers up to a new system. In the opinion of the writer neither of these difficulties is as serious as some people would try to have us believe and it is chiefly "selfish interests which are blocking the way of reform."

The cooperation of all scientists, the various reform leagues, the government bureaus and as many others as possible should be enlisted for the passage of the bill in favor of the metric system at as early a date as possible.

A. F. GILMAN
RIPON COLLEGE

THE YELLOWSTONE PARK

TO THE EDITOR OF SCIENCE: I have tramped, with knapsack and sleeping bag, more than a thousand miles through the wildest and roughest parts of the Rocky Mountains, camping out in the cheapest and most primitive fashion; and every one will understand, I think, that it is not as a molly-coddle that I say, from my experience during the summer of 1911, that the bear in Yellowstone Park are an outrageous nuisance.

I know of no more flagrant example of detached, red-taped sophistry than this: "A few instances are on record where people have been attacked and injured by bears" but "in all cases where the facts were known the person injured was more or less to blame."[1] In

[1] See letter of Jesse L. Smith in SCIENCE of June 20.

speaking of this as detached I mean that it must have been written either with little knowledge or scant appreciation of the facts.

During the summer of 1911 I traveled with three boys about 300 miles through the country south and southeast of the Yellowstone Park, and one night a man who had been turned away from the Reclamation Camp at Jackson Lake was seen prowling around our wagon, which was at some distance from the tent where we were sleeping. A little biggity talk about guns and shooting was enough to scare the poor fellow away, but if he could not have been scared away he would certainly have gotten a dose of lead.

When we got into the Yellowstone Park we pitched our tent in a good place and proceeded to take in the wonderful sights; but we were warned by a soldier that we must stand guard over our camp after dusk or we would be cleaned out by marauding bear. How would you, curious reader, like to be tied down to guard duty over a side of bacon in Yellowstone Park? We went there for another purpose; but we remembered that we were a long way from a base of supplies!

Our first night in the park we slept with an axe under our pillow, thinking to drive Mr. Bear out of our pantry if he should come in the night; which is precisely the most foolish thing we could have done, Mr. Jesse L. Smith to the contrary notwithstanding. If Mr. Bear should happen to be Mrs. Bear with a cub it would be pretty dangerous business. One of the killings (man killings) we heard of during the summer of 1911 was a three-cornered affair or rather a three-in-a-row affair of this kind, and the man was unfortunately in the middle. Quoting from the park superintendent we would say that this man "was more or less to blame." At any rate we must admit that he was thinking too much of his stock of grub and of his remoteness from a base of supplies. But we would not have been blameworthy if we had shot the poor hobo from Jackson Lake. No, before God, we wouldn't.

Mr. Jesse L. Smith's reference to the frightening of bear with Roman candles reminds me of the crank who proposed to squirt olive oil and phosphorus over the Bastile to set it on fire at the beginning of the French Revolution. Phosphorus was only a chemical curiosity in those days, and probably all that had ever been made would have amounted to less than a pound, and it is extremely amusing to read Carlyle's exhortation to this visionary crank to bring forth his phosphorus and olive oil! The unfortunate but blameworthy man above referred to ought to have had sense enough to have used a Roman candle, or, better still, a hand grenade filled with liquid anhydrous ammonia! He showed his respect for law, however, in not using a bomb containing liquefied prussic acid; that would have killed the bear.

We lost all of our grub at the Canyon, and we ate at the hotels during the remainder of our trip; a very pleasant change after eight weeks of rough and tumble camping, but extravagantly expensive from a teacher's point of view. We knew directly of several small camps besides our own that were raided during our five or six days in the park. Greenhorns, Mr. Smith would say. Yes, they were greenhorns in the park under the fatherly care of the superintendent and his company of cavalry; but it would not have been healthy for man or beast to have gone very far on that assumption outside of the park.

We heard incessant talk about marauding bears; just as we hear incessant talk about the weather in Kansas, without fear, but with deep concern. And we heard circumstantial accounts of at least two campers who were seriously hurt in trying to save their grub. Their midnight sallies were not like "routing a neighbor's cow from a garden patch," to quote Mr. Smith.

The simple fact is that either ninety-five per cent. of the Yellowstone Park bears must be killed off or soldiers must be placed on all-night guard around the chief camping places in the park. Mr. Smith, and to some extent also the park superintendent, make themselves ridiculous in looking at this matter in the spirit of complacent statisticians unmindful

of the cold fact that the exceptional cases are absolutely not to be tolerated.

"I would not have a single person," says Mr. Smith, "miss the great fun and superior advantage of camping out during the tour of the park because of the fear of the bears." Mr. Smith is pedantic in his choice of words. It is purely a question of vermin. And Mr. Smith, who boldly routs marauding bear with Roman candles, perhaps, if properly armed, he would not be afraid even of a bed bug.

W. S. FRANKLIN

SCIENTIFIC BOOKS

An Illustrated Flora of the Northern United States, Canada and the British Possessions from Newfoundland to the parallel of the southern Boundary of Virginia, and from the Atlantic Ocean westward to the 102d Meridian. By NATHANIEL LORD BRITTON, Ph.D., Sc.D., LL.D., Director-in-Chief of the New York Botanical Garden, Professor in Columbia University, and HON. ADDISON BROWN, A.B., LL.D., President of the New York Botanical Garden. The descriptive text chiefly prepared by PROFESSOR BRITTON, with the assistance of specialists in several groups; the figures also drawn under his supervision. Second edition, revised and enlarged. In three volumes: Vol. I., *Ophioglossaceae* to *Polygonaceae*, Ferns to Buckwheat (pp. xxix + 680); Vol. II., *Amaranthaceae* to *Loganiaceae*, Amaranth to Polypremum (pp. iv + 735); Vol. III., *Gentianaceae* to *Compositae*, Gentian to Thistle (pp. iv + 637). Octavo. New York, Charles Scribner's Sons. 1913.

Nearly seventeen years ago the writer of this review had the pleasure of making a notice[1] of the first volume of "a new manual of systematic botany," the same being the first edition of the book now before us. Two sentences in that review may be reproduced here.

It is in every way a new work—new in its plan, new in its descriptions, new in its illustrations. . . . It will give renewed life and vigor to systematic botany, and doubtless will be the means by which many a student will be led to the study of the more difficult families.

Less than two years later in a notice of the third volume[2] the writer commented upon the "Rochester nomenclature" of the work, and said:

It is inevitable that one result of its publication ["Illustrated Flora"] will be that the number of those actively opposing these modern features will rapidly grow less. It will soon be much easier to follow the modern innovations along the plain highway here made than to continue in the less and less frequented paths of the conservatives.

These prophecies have long since come to pass, and their quotation now enables us to see how far we have traveled since they were written. When the original volumes were written they seemed very radical, and almost revolutionary, but now as one runs them over they have lost their radicalness, and do not appear at all revolutionary. In their latest version, in this second edition, even the conservative reader finds little that will shock him. In these years we have moved very far in our notions as to systematic botany, and the "Illustrated Flora" has been a potent force in bringing about this change. The authors are to be congratulated for the part they have played in this revolution in systematic botany.

Comparing the present edition with the first we find that the whole number of species has risen from 4,162 to 4,666, while the genera have increased from 1,103 to 1,229, and the families from 177 to 194. Of the grasses (*Gramineae*) the first edition contained 371 species, while in the second there are 466. So the species of *Carex* are increased from 205 to 242. The *Compositae*, in the wider sense (including also *Cichoriaceae* and *Ambrosiaceae*) are increased from 569 to 625.

The treatment of *Crataegus* in the two editions may well be contrasted. In the first edition 15 species are recognized as occurring within the range covered by the "Flora," and the remark is made that "four or five others

[1] *Am. Nat.*, October, 1896.

[2] SCIENCE, August 12, 1898.

occur in the southern and western parts of North America," and for the genus, as a whole, it is said that there are in the world "about 50 species, natives of the north temperate zone, Mexico and the Andes of New Granada." In the second edition 73 species are figured and described from the same range, while the following statement is made for the genus as a whole. "About 300 species, natives of the north temperate zone, the tablelands of Mexico and the Andes; the center of distribution is the eastern United States." The genus has been of great taxonomic interest for ten years, about 1,000 species having been described from the United States during that period. Data are fast accumulating tending to show that many of these newly described species are hybrids.

In the Introduction (pp. ix, x) one finds the following condensed version of the "American Code," which takes the place of the longer statement in the first edition:

1. The nomenclatorial type of a species or subspecies is the specimen to which the describer originally applied the name in publication.
   (*a*) When more than one specimen was originally cited, the type or group of specimens in which the type is included may be indicated by the derivation of the name from that of the collector, locality or host.
   (*b*) Among specimens equally eligible, the type is that first figured with the original description, or in default of a figure the first mentioned.
   (*c*) In default of an original specimen, that represented by the identifiable figure or (in default of a figure) description first cited or subsequently published, serves as the type.
2. The nomenclatorial type of a genus or subgenus is the species originally named or designated by the author of the same. If no species was designated, the type is the first binomial species in order eligible under the following provisions:
   (*a*) The type is to be selected from a subgenus, section or other list of species originally designated as typical. The publication of a new generic name as an avowed substitute for an earlier invalid one does not change the type of a genus.
   (*b*) A figured species is to be selected rather than an unfigured species in the same work. In the absence of a figure, preference is to be given to the first species accompanied by the citation of a specimen in a regularly published series of exsiccatae. In the case of genera adopted from prebinomial authors (with or without change of name), a species figured by the author from whom the genus is adopted should be selected.
   (*c*) The application to a genus of a former specific name of one of the included species, designates the type.
   (*d*) Where economic or indigenous species are included in the same genus with foreign species, the type is to be selected from (1) the economic species or (2) those indigenous from the standpoint of the original author of the genus.
   (*e*) The types of genera adopted through citations of nonbinomial literature (with or without change of name), are to be selected from those of the original species which receive names in the first binomial publication. The genera of Linnæus's "Species Plantarum" (1753) are to be typified through the citations given in his "Genera Plantarum" (1754).

Enough has been said to show that the new edition differs so much from the earlier one that it must find a place upon the shelves of every botanical library.

It only remains to be said that while the new edition was passing through the press Judge Brown closed his labors, but not before he had seen the pages of the new book. To the surviving author we must offer our congratulations upon the publication of the present edition.

Charles E. Bessey
The University of Nebraska

The Mathematical Theory of Heat Conduction. By L. R. Ingersoll and O. J. Zobel. Ginn & Co., Boston. 171 pages.

The accurate solution of problems in heat transmission has been neglected in the past by engineers. They have been content to arrive at approximate results by empirical methods or by guessing. With the increased use

of electricity for the generation of heat has come the need for greater accuracy in calculating the rate of heat flow through insulation, the temperature distribution in bodies after any time interval, etc. In 1811 Fourier developed the mathematical theory of the conduction of heat, but until lately the practical applications have been few. The "Mathematical Theory of Heat Conduction," by L. R. Ingersoll and O. J. Zobel, although primarily a text-book, is a step towards making Fourier's methods available to the engineer.

After a historical sketch in the first chapter, the authors derive the Fourier conduction equation from the fundamental laws of the flow of heat. This equation is solved first, for bodies in which the temperature distribution has become steady. These bodies are the thin plate, the long thin rod, the infinitely long thin rectangular plate, etc. The general cases in which the temperature is not steady are then attacked. Equations are developed, giving the temperature as a function of the variables time and distance, the temperature distribution at zero time being known. These general solutions require Fourier's series and integrals, which are developed, and extended to the limits $+\infty$ and $-\infty$. Solutions are given for such specific shapes as the infinite solid, the semi-infinite solid, the slab, the thin rod, the sphere, etc. Also solutions are given for the cases where there is either an instantaneous or a permanent source of heat in the interior of the body. No attempt is made to prove that any of the solutions are unique, as this rightfully belongs to larger treatises.

Throughout the work the authors give many numerical applications, such as calculating the flow of heat through furnace walls; the rate of cooling of a setting concrete wall in cold weather; the heating effect of thermit welding; the rate of cooling of steel in tempering; the rate of cooling of the earth, taking into account the effect of radioactivity; the rate at which heat penetrates a fire-proof wall, etc.

In deriving the fundamental equations the authors assume, in common with previous writers, that thermal resistivity does not vary with temperature. The error due to this assumption is usually unimportant for metals, but the so-called insulating materials often show large temperature coefficients. It is necessary to consider this in many cases if we are to secure accurate results. In dealing with problems involving heat losses from a surface exposed to the air, the authors follow the custom of assuming the rate of energy loss to be proportional to the temperature of the surface. It is well know that this is not true, and there is sufficient data available in the literature to allow a much closer approximation than can be secured with the above assumptions.

One of the most important applications of the theory of heat conduction is to problems in which there are permanent sources of heat, as in dealing with electric furnaces. The authors solve a few problems of this kind, but they do not give them nearly enough attention.

Considerably more values of thermal conductivity constants have been published than are given in the appendix. The statement that "in the constants for poorer conductors the disagreement between different observers is frequently 50 per cent. or more" is correct. But there need be no such disagreement if the conditions of the measurements are given.

The book is quite the most satisfactory yet published, as a text for the study of heat conduction, and it should be widely used in engineering schools. As a reference book for the practising engineer it leaves much to be desired, although the material included in it is made more easily available than heretofore. It is a long step towards the development of an engineering knowledge of the transmission of heat.

C. P. RANDOLPH

SPECIAL ARTICLES

THE NEGATIVE PHOTOTROPISM OF DIAPTOMUS THROUGH THE AGENCY OF CAFFEIN, STRYCHNIN AND ATROPIN

SINCE the discovery that fresh-water crustacea which are normally indifferent to light could be made positively phototropic by means

of acids, alcohols and esters,[1] there have been various attempts to bring about a negative reaction by chemical means. It is true that raising the temperature, or the addition of alkalis, tends to break up positive collections of these animals, but such treatment does not cause a negative gathering. Until recently ultra-violet light of wave-length shorter than 3,341 A. u. has been the only generally successful means of artificially causing a negative collection of fresh-water crustacea.[2] But it has lately been shown by Drzewina[3] that the larvæ of lobsters give such a negative response when treated with potassium cyanide.

In a former paper it was pointed out that the addition of strychnin to water containing *Daphnia* destroys the positively phototropic responses of these animals, and that such treatment when applied to *Diaptomus* causes them to form a strong negative collection. Atropin gives the same result, but to a less marked degree.[4]

In order still further to test the effect of alkaloids and other substances upon the light reactions of fresh-water crustacea, the following experiments were carried out at the New Monterey laboratory during December, 1912. The material used consisted of *Diaptomus bakeri*[5] taken from the Del Monte lake. The freshly collected animals were put into finger-bowls, each of which contained 25 c.c. of lake water. The preparations were then placed upon a table near the window, but never in direct sunlight. Normally, *Diaptomus* is indifferent to light, the individuals remaining pretty evenly distributed about the dish. But the addition of acids, alcohols or ether always causes the animals in the dish treated to form a dense collection on the window side. In order to insure equal concentration of a given substance throughout the preparation, the latter was always thoroughly stirred after the addition of the reagent.

If, now, to a normal preparation there be added 0.6 c.c. of a 1 per cent. solution of caffein, in two minutes the animals all collect in a dense cluster on the side of the dish away from the light, *i. e.*, they become negatively phototropic. This collection remains thirty to thirty-five minutes. It was thus possible to observe opposite effects in two dishes of the same material placed side by side, the one with all of the animals forming a dense cluster nearest the window (caused by adding the acid), the other with all the animals collected on the side of the dish farthest from the window (caused by adding the caffein). In either case after the characteristic gathering, if the dish be turned through an angle of 180° the crustacea in it swim back across the dish and re-form, the collection having the former position with reference to the light. The addition of 0.05 c.c. of a ½ per cent. solution of strychnin nitrate to a normal preparation causes all of the animals to become negatively phototropic, but does not result in their forming a dense collection as in the case of caffein. Strychnin, because of its toxicity, causes the *Diaptomus* treated with it to die within five minutes. It was also found that if 0.5 c.c. of a ¼ per cent. solution of atropin (alkaloidal) be added to a normal preparation of *Diaptomus*, we obtain much the same result as with strychnin, *i. e.*, a weak negative collection. Other alkaloids such as digitalin, pilocarpin, physostigmin, ricin and cocain, gave no significant results with this form.

If the *Diaptomus* were first made positively phototropic by the addition of alcohol or acids, it was found impossible to alter their response by the action of caffein, strychnin or atropin. On the other hand, animals which had formed a negative collection under the influence of caffein, if treated with carbonated water, at once changed their response and, swimming to the light side of the dish, formed a positive gathering. This confirms my former statement:

[1] Loeb, J., "Dynamics of Living Matter," p. 131.

[2] Loeb, G., *Pflüger's Archiv*, Bd. 115 s.; Moore, A. R., *Journ. Exp. Zool.*, Vol. 13, p. 573.

[3] Drzewina, Anna, *C. R. Soc. Biol.*, Vol. 71, p. 555.

[4] Moore, A. R., Univ. Calif. Publ. Physiology, Vol. 4, p. 185.

[5] I am indebted to Professor Kofoid for the identification of this form.

While negative phototropism in *Diaptomus* can be reversed by acids, positive phototropism brought about by chemical means can not be reversed by strychnin (atropin or caffein).[6]

A. R. MOORE

THE UNIVERSITY OF CALIFORNIA,
July 8, 1913

THE POWDERY SCAB OF POTATO (SPONGOSPORA SOLANI) IN MAINE

THE potato tuber scab caused by *Spongospora Solani* (Brunch) has been known in Europe since 1842. It was recently reported from Canada by Güssow,[1] but has hitherto not been found in the United States. That it would become established here has been feared by those acquainted with the serious injuries it causes in Great Britain, whence heavy importations of potatoes were made in 1911 and previous years, to supply American markets.

The writer discovered this disease on June 23 in potatoes just brought to Houlton from Presque Isle, Aroostook County, Maine. There is no probability as yet that a large amount of *Spongospora* exists there, but 84 diseased tubers were sorted out of four barrels, which represented a lot of 500 barrels.

The milder forms of powdery scab resemble the common Oospora scab. The pustules are at first closed, but later break out into large open sori. Twenty-six of the tubers collected showed this form.

The source of the disease is not known. The original infection may have been brought from Europe before the Plant Quarantine Act went into effect or seed potatoes bearing the disease may have come from the adjacent province of New Brunswick, in Canada, where powdery scab already occurs.

It is hoped that pathologists all over the country will now watch for this disease and that every effort be made to stamp it out.

I. E. MELHUS

BUREAU OF PLANT INDUSTRY,
U. S. DEPARTMENT OF AGRICULTURE,
HOULTON, MAINE

[6] Moore, A. R., loc. cit.

[1] *Phytopathology*, February, 1913, p. 18.

A NEW SECTION SOUTH FROM DES MOINES, IOWA

THE grading of a new railroad line from Des Moines to Allerton, passing from Polk County through Warren, Marion and Lucas into Wayne County, affords an excellent series of exposures such as have never before been available in this region. The relation which this series makes evident assists in the interpretation of observations already recorded, and the section itself serves as a standard with which to compare work yet to be accomplished in south central Iowa and adjacent Missouri. The general relation will be of interest to all who keep informed on the Pleistocene work of the country.

The Loess

The best exposure of loess that the writer has seen in this portion of the state is south of Des Moines, half a mile north of Coon Valley. Here twelve to fifteen feet of grayish yellow porous loess with faint horizontal lamination may be seen capping the bluff for a quarter of a mile. At the two ends of the cut the loess is exceedingly fossiliferous, and charged with concretions. In the hills east of Carlisle, even as far as Hartford, a distinct fossiliferous loess may be seen; but further south it does not form a conspicuous deposit. On the brow of hills away from the highest portion of the upland it is not present at all.

The "Gumbo"—The Loveland

Along the sides of all cuts through the upland may be seen a clay yellowish above, bluish below, of a thickness varying from a few feet up to perhaps twenty feet. It is nearly free from pebbles, but here and there a few scattered ones may be found that are half an inch in diameter, and very rarely one as large as an inch. Two were recently found as large as two inches in diameter. There are found scattered through the clay grains chiefly of granite about an eighth of an inch in diameter. The clay is generally free from distinct stratification, often silty in appearance, and slumps badly throughout the entire length of the railroad. In the upland where thickest it is found on the bowlder and pebble-bearing portion of the Kansan drift with no

intervening plane of oxidation; but in places, and apparently at lower levels, a line of scattered pebbles is sometimes evident. In other places at still lower levels the plane of separation is marked by bowlders and a yellowish oxidized surface of the bowlder-bearing portion of the Kansan, the horizon that is so commonly seen in Warren, Madison and Lucas counties, which appearance led Bain to coin the term "ferretto." Here and there the deposit is replaced by beds of stratified sand revealing places of current action.

This is the deposit which McGee called the "gumbo" of southern Iowa. Perhaps there is no more important relation brought to light in the entire series of exposures than the relation of this common deposit for this part of the state. It is so free from pebbles, weathers so quickly, and forms a soil so like that formed from loess that it has by some (including myself) been judged to be a modified loess; but these excellent extensive exposures of the deposit in many variations leave no chance to doubt the conclusion that this "gumbo" is not a loess, but is related to the Kansan drift and deposited in the closing stages of the Kansan invasion.

The writer has thus far looked in vain for evidences of kames and drumlins. He has also in previous years endeavored to trace the boundaries of this same "gumbo" to ascertain whether it thinned out as if in basins, but found it through the upland and dissected by ravines. A main difficulty has been to distinguish between a low-ground gumbo and an upland gumbo, which were apparently connected along the sides of the large ravines. The sides of these new railroad cuts and the various excavations in low ground reveal such mixture and gradation due to wash and creep, in which stratification due to wash has not persisted, that it now seems necessary to recognize this form of low-ground gumbo as not contemporaneous with the upland gumbo, but largely derived from it. However, gumbo ten to twenty feet above the surface of the river valleys is found banked in against and on the Kansan drift, and apparently identical with the upland gumbo. (Such is the deposit at the Siegel Brick and Tile Works at Osceola.)

In the deep cut east of Sandyville the deposits above the bowlder-bearing portion of the Kansan drift are in two portions: a lower portion six feet thick and an upper portion one to two feet thick. The surface of this lower portion contains hemispherical depressions three to five feet in diameter filled with clay of the upper portion. It is probable that this irregular surface was due to a slight final movement of the ice before the last of the Kansan ice disappeared. No pebbles are found in the depressions, as might be expected if the depressions were potholes, and the cross sections are too rounded to appear due to stream erosion. The whole appearance suggests moulding by overriding ice.

Hitherto the oxidized portion of the Kansan drift found at a depth of thirty feet from the surface in wells of the upland, seen as the upper level of the "ferretto" at the same distance below the upland on so many hillsides, and marked on others as close to the bottom of the upland gumbo, was judged to be the oxidized surface of the Kansan plain, so conspicuous throughout south central Iowa, the gumbo itself being then considered a later deposit on this plain. Classing this gumbo as related to the Kansan drift rather than to the post-Kansan deposits raises the supposed level of this Kansan ground moraine by an amount equal to the thickness of the "gumbo," twenty to thirty feet, and supplies that much of uneroded material that in places could well have been surface settlings on the upland of the extensive Kansan plain as the Kansan ice gradually disappeared; in other places a deposit in hollows on the surface; in other places not deposited at all, or eroded since deposition.

On comparing the evidence revealed in this series of railroad cuts with the description which Professor B. Shimek gives of the "Loveland" found along the Missouri River in the western part of the state, announced in the *Bulletin of the Geological Society of America*, 1910, in Science, 1910, and very fully described in his "Geology of Harrison and Monona Counties," volume 20, Iowa Geo-

logical Survey, it is evident that this "gumbo" corresponds to his "Loveland," which he has found there well exposed and widely distributed, and has been the first to recognize.

The Bowlder-bearing Portion of the Kansan

At the fine exposure at Coon Valley only a trace of Kansan bowlder-bearing clay is left; but it appears in all the deep cuts to the south. The characteristics of this portion of the drift have been so frequently stated that a description is here omitted. South of Whitebreast Creek and across Lucas County numerous sand bowlders form a conspicuous feature of the Kansan bowlder clay. In places, where "gumbo" is not present, there is evidence of post-Kansan wash.

No Aftonian nor Nebraskan Exposed

The study of the section was undertaken with the expectation that numerous exposures of Aftonian interglacial deposits and of Nebraskan drift (sub-Aftonian) would be found; but the cuts are through the hills, and fills extend across the valleys. At the Avon gravel pit in the southern part of Polk County a steam shovel is now removing a coarse sand close to a level at which near by mastodon or elephant remains are said to have been found a number of years ago. These deposits are thought to be of Aftonian age. In a cut in Marion County the bottom of the Kansan drift there exposed contained a bowlder of blue clay apparently Nebraskan. With the exception of these two places all evidence of distinct Aftonian and of distinct Nebraskan is wanting. (The work of excavation is not fully completed near the southern part of Marion County.)

The Des Moines Formation

The Des Moines shales are frequently found above the level of the track bed from the outcrop near Coon Valley to the northern boundary of Lucas County, south of which place they appear but once. These exposures afford excellent opportunity to study variations in a preglacial surface.

The exposures in their present perfection will not last long, but at present they will well repay a day's tramp south from Des Moines, or, at Chariton, north from Chariton River.

Acknowledgments

During the summer several of the most important exposures were visited by Professors George F. Kay, B. Shimek and James H. Lees together with the writer, and the conditions found discussed in the field; but the parties named are not responsible in any way for the above presentation.

JOHN L. TILTON

THE AMERICAN ASSOCIATION OF MUSEUMS

THE eighth annual meeting of the American Association of Museums was held in Philadelphia, June 3–5. The most prominent feature of the convention was the discussion of general questions of policy in relation to future work.

The representation of museums of science in the membership has always largely exceeded that of museums of art, although the essential idea in the organization of the association was to afford a common meeting ground for the discussion of the "principles of organization and administration of museums, and their problems of technique, rather than matters of art, history or science as such." There is a strong sentiment among both science and art members that, since all museums exist for the purpose of giving visual expression to ideas, the methods of accomplishing this purpose must be fundamentally similar and vary only in application according to the nature of the material and of the ideas to be expressed. The field of the association, therefore, in no way conflicts with any of the many scientific, artistic or historical societies. For the purpose of promoting a more general appreciation of these facts, and to endeavor to secure greater equality of representation of the various classes of museums in the membership and in the programs of the meetings, a special committee was appointed. With an art man as president for the ensuing year, the time seems particularly opportune for this movement which is so essential to the full function of the association.

A committee was also appointed to consider what methods the association may adopt to promote the increase and successful development of

museums. It is generally recognized that the field for special museums in our large cities is extending rapidly, not only in the more familiar forms of museums of art, history and science, but in the newer form of industrial, commercial, technological and social museums. It is also recognized that the field of the general museum as a center, not only of education, but of civic and social movements in smaller communities is only beginning to be appreciated. These smaller institutions differ in many ways from those of the larger museums of more limited scope, and they feel the need of organized assistance from the association.

Taken as a whole, the papers and discussion at recent meetings indicate a desire that the association shall formulate a digest or compendium of museum practise which may be used as a guide by the smaller museums. The Directory of Museums, published for the association in 1910, was designed to afford a part of the data for such studies, and more recent statistics on some of the points covered by that work will be available in the forthcoming report of the United States Commissioner of Education, which will include, for the first time, a section on museums.

The following papers were read at the meeting and will be published in full in the *Proceedings:*

"Industrial Museums for American Cities," Franklin W. Hooper, The Brooklyn Institute of Arts and Sciences, Brooklyn, N. Y.

"A Group Showing Animals of the Wharf Piles," Roy W. Miner, The American Museum of Natural History, New York.

"Meteorite Collecting and Collections," Oliver C. Farrington, Field Museum of Natural History, Chicago.

"A Method of Mounting Wet Specimens Showing their Natural Environment," Charles F. Silvester, Museum of Princeton University, Princeton, N. J.

"Use of Museum Resources in Public Instruction," Witmer Stone and Stewardson Brown, Academy of Natural Sciences, Philadelphia.

"Observations in European Museums of Art," Benjamin Ives Gilman, Museum of Fine Arts, Boston.

"Museum Work at the Capital of Canada," Harlan I. Smith, Victoria Memorial Museum, Ottawa, Canada.

"Museum of the Ohio State Archeological and Historical Society," William C. Mills, Ohio State Archeological and Historical Society, Columbus, O.

"Ichthyological Explorations in Colombia," C. H. Eigenmann, Carnegie Museum, Pittsburgh, Pa.

"Why this Association should Promote Museum Extension Work," W. B. Ashley.

"The Museums and the Boy Scouts," Charles Louis Pollard, Staten Island Association of Arts and Sciences, New Brighton, N. Y.

"Museum Work for the Boy Scouts," William L. Fisher, The Philadelphia Museums, Philadelphia.

"Insurance, Retiring Allowances and Pensions for Museum Men," M. J. Greenman, Wistar Institute of Anatomy, Philadelphia.

"Needless Regulations in Museums," A. R. Crook, Illinois State Museum, Springfield, Ill.

"The Functions of Museums and the Question of Special Exhibitions," Frederic A. Lucas, American Museum of Natural History, New York.

"The Museum Point of View in Botany," Edward L. Morris, Museum of the Brooklyn Institute of Arts and Sciences, Brooklyn, N. Y.

"The Molding and Casting of Mushrooms and other Plants," Antonio Miranda, Museum of the Brooklyn Institute of Arts and Sciences, Brooklyn, N. Y.

"A Celestial Sphere—An Apparatus Installed to Promote Interest in Astronomy," W. W. Atwood, Chicago Academy of Sciences, Chicago.

"The Deutsches Museum at Munich," Charles R. Toothaker, The Philadelphia Museums, Philadelphia.

"Legislation in the Interest of the Ohio State Museum," William C. Mills, Ohio State Archeological and Historical Society, Columbus, O.

The following officers were elected for the ensuing year:

President—Benjamin Ives Gilman, secretary of the Museum of Fine Arts, Boston.

First Vice-president—Oliver C. Farrington, curator of geology, Field Museum of Natural History, Chicago.

Second Vice-president—Arthur Hollick, curator of fossil botany, New York Botanical Garden, New York.

Secretary—Paul M. Rea, director, The Charleston Museum, Charleston, S. C.

Treasurer—W. P. Wilson, director, The Philadelphia Museums, Philadelphia.

Councilors (1913–16)—Henry L. Ward, director, Public Museum of the City of Milwaukee, Milwaukee; Edward K. Putnam, director, Davenport Academy of Sciences, Davenport, Iowa.

The association selected Milwaukee as the meeting place for 1914.

PAUL M. REA,
Secretary

SCIENCE

FRIDAY, AUGUST 1, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-On-Hudson, N. Y.

THE GOOD ENGINEERING TEACHER, HIS PERSONALITY AND TRAINING[1]

AT the meeting of Section E on Engineering Education of the World's Engineering Congress which was held in Chicago in 1893 in connection with the World's Columbian Exposition, there were assembled "seventy or more" engineering educators from the United States and eight or more foreign countries. This society owes its existence to the congress and to the thought and labors of Professor Ira O. Baker, chairman of the Division Committee, and Professor C. Frank Allen, its secretary *pro tem.* Of the seventy charter members, twenty-nine have either gone to their reward or have withdrawn from the society. Only forty-one of the seventy are now members of the society. Eleven of the living past-presidents are charter members, three became members in 1894, and one each in 1895, 1897 and 1902. That was twenty years ago. Some of us are no longer boys, even if we do feel as young and as full of enthusiasm as we did then. If time and your patience permitted it, and I were able, it would delight me to recall in great detail the lives and examples of some of the giants in engineering education whose successors we are—of the cultured Thurston, of that dynamic giant, DeVolson Wood, of that inventive genius, Robinson, of the courtly Chanute, of the erudite Johnson, and of the versatile Storm Bull. I offer you my congratulations on being allowed to follow where they have led the way.

But after twenty years of this society's

[1] Address of the President of the Society for the Promotion of Engineering Education.

existence for the promotion of engineering education, at this its twenty-first meeting, when our growth betokens that we have come to our legal majority, at least in years, I desire to lead your minds into the consideration of what is a good engineering teacher and to give you an appreciation of his personality, and what he is as I have seen him in three score and more of engineering colleges and technical schools.

What then is a good teacher? And my first answer is that he is one who knows enough of his subject to have something to impart. I sometimes think the reason men from the highest ranks of consulting engineers so frequently make poor teachers, from the point of view of the students, is that they know too much, and can not appreciate the fact that the students are down in the basement of the structure whose façade they are embellishing with artistic points of elegance and efficiency, and that the students are crawling on hands and knees along the path they are traveling with seven-league boots. In order that the teacher shall have something to impart, he should have had a proper education and some training, experience, travel and observation, as these are among the necessary qualifications for a good teacher. The man who has never earned his daily bread in the close commercial competition of the factory, works or mine, needs to learn one of the essential requirements of the successful engineering teacher, namely, to have rubbed elbows with workingmen of the artisan type and to have measured himself by their standards of knowledge and skill. One who has received only the education that he is trying to impart, possibly at his alma mater, probably in the same room in which he received it, who has never cut himself loose from his college's apron strings, and who has not taught or worked elsewhere, is not likely to make a good teacher until he has been trained in the school of experience elsewhere. If graduate students should migrate for their best good, surely college teachers should do the same. In a previous paper before this society I have already referred to one institution, almost one hundred per cent. of whose teachers in one department are the educational offspring of the great mind which presided over the department for thirty years. Experience of any kind always serves a teacher well, and the more he has had of that which pertains to the subject that he is teaching, the better it will be for him and his students. Travel and inspection trips, to learn by observation how others are doing the same thing that he is expected to do, are extremely broadening and take him out of his natural groove. It is needless to say that continued reading and increase in one's knowledge of his profession is absolutely essential for the advancement of the good teacher.

A good teacher is one who can talk on his feet audibly enough to be heard without effort and intelligently enough to be understood without subsequent correction. For, if the listener can not hear what is being said for his instruction, both parties are wasting time which is more or less valuable. If the recipient of the instruction continuously fails to get an intelligent understanding of what has been said, he has no right to be in attendance; and, similarly, if the teacher continuously fails to give an intelligent understanding of what he is trying to say, he should be removed and not allowed to waste the valuable time of the students. A man who can not impart his knowledge can not be a good teacher. Hence, health, adequate previous rest and endurance are essential to the good teacher. Few of us, I think, appreciate the difference in the instruction given and taken in September and in May, on Monday and on

Friday, after a holiday spent in restful occupation and amusements and after an entertainment lasting until far past midnight. Some of us occasionally fail to consider and measure accurately the cash value of an hour of a class's time. We should be greatly disturbed if in our factory the power were needlessly shut off during the working hours of the day, or the lights went out at night, or the subsistence department failed to provide suitable food and lodging for our workmen, and we would at once discover the causes for this industrial inefficiency; but if the class is made to wait while a visitor or an assistant detains us, we may have little remorse, or indeed thought, concerning our academic inefficiency. To attend an engineering college it costs a student at least one dollar per week per credit hour of college work, or from sixteen to twenty dollars per week. If, therefore, the teacher in a college of engineering is absent without a substitute from a one-hour class-room engagement, it may be causing each of the ten to two hundred students to spend a dollar in needlessly trying to fulfil his part of the contract with the institution. The same is true of inexcusable latenesses.

A good teacher is one who has an unimpeached and deserved reputation for mental honesty, right living, patience under harassment and sound character. The engineering teacher who describes tricks of the trade, petty dishonesties, evasions of both the spirit and the letter of the law, without showing at least his disapproval of them, who shuts his eyes to dishonesties in class-room and college life, is neither a good teacher nor yet a good citizen. The teacher who is a leader in trickery, deceit and bluff during the term and who permits students to sit in an examination room so close together as to be under constant temptation to undesired dishonesty is *particeps criminis* to any dereliction of the student then, and possibly later. When cheating in examinations is made a *sine qua non* for honor and high grades, if not for graduation, and when the most skillful compiler of invisible ponies and the most successful cheater becomes the honor man of the class, as I have heard reported in recent trips among the colleges, it would seem that an old-fashioned course in moral philosophy and ethics should be in order for both the teachers and the students. We all fail, I fear, frequently enough, but we should not be forced, or allowed, to fail inordinately. Occasionally we hear condonation expressed at the human frailties of the teacher, because he is considered as a genius in his specialty, and on account of his lovable qualities. Far be it from me to cast stones at my brother man, but I have never been able to discover a reason why a drunkard, or a libertine, should be tolerated in the teaching profession and frowned out of society in other professions and not allowed to work where the physical well-being of others was involved. Surely the mental and the spiritual well-being of our young men are paramount to their physical existence.

The one moral trait which seems to be most frequently demanded above all others from the teacher is that of patience. Some of us do not enjoy walking with persons who walk slowly or with very short steps, and who take a long time to get over very little ground. Similarly, we have to go equally slowly in expounding a new problem to a class, or in drawing out of even the average student the principle underlying the problem in hand, and in causing him to think about the subject consecutively and logically. We have all asked ourselves at the end of the hour, "How many in that class really took in the full significance of what I was talking about?"

If this is true with the average class, how much more is it so with those members who are lazy or are naturally slow in their mental operations?

From the above it follows as a matter of course that the good teacher should deserve the respect of his students and his colleagues as a man, as a teacher and as an engineer. I think it frequently happens that the students know our failings and our strong points better than we do ourselves, or than they are known by our superiors. Student criticism may sometimes be unjust for want of full and complete information, but it must be remembered that the young human mind is likely to be as keen in its perceptions as is the older mind of the man who occupies the other end of the room.

Another requisite in the good teacher is unbounded enthusiasm for and intense loyalty to the work of the teacher and of the engineer. We can tolerate the hireling in the commercial office and the drafting room, and the time-server may have to be put up with out on the works and in the mine, but the teacher, as a leader of young men and as a man who should be looked up to with some degree of that kind of respect which may grow into veneration should be so bubbling over with enthusiasm that it will be contagious.

That prince of cultured scientists, Dr. S. Weir Mitchell, in giving at the semi-centennial celebration of the foundation of the National Academy of Sciences some of his recollections of the eminent men of science whom he had known, told the story of Professor Joseph Leidy's being asked "if he never got tired of life." "Tired!" he said, "Not so long as there is an undescribed intestinal worm, or the riddle of a fossil bone or a rhizopod new to me." So, the enthusiastic teacher is never tired, so long as there is an intelligent boy to be trained or a mind to be developed. The engineer sets in motion the wheels of thousands of machines; the successful educator sets in motion the wheels of a thousand minds. Such a man can always get the work out of his students, even if they have to curtail the time properly due to some other instructor who is less inspiring. The enthusiastic teacher never counts the cost to himself of his labor for those whom he loves to call "his boys."

I am of the opinion that our engineering colleges are less handicapped than are the academic colleges by the services of men who are teaching for a year or two either while studying for the bar or for holy orders, or to enable them to repay the debts contracted for their college education by the means which will permit the least effort during the shortest time. As a rule, the call to work in the bustle of the manufacturing and constructive world is preeminent in the mind of the engineering graduate. He is ready for the fray, and to-day he wants to get into it as never before, and no waiting until cooler weather or until after a summer vacation for him. "I am going to work next Monday," is his battle cry on commencement day. The courage of youth is beautiful to behold, and his zeal is a lesson to his teachers and to those who are following him.

Akin to enthusiasm for his work in the good teacher is his inspirational value to his students and his colleagues in the faculty. The former is the child of youth; the latter is the product of age and genius. When the teacher begins to lose his enthusiasm, he should begin to think that possibly he may be getting old, or else lazy. Not infrequently, however, the teacher who is devoid of enthusiasm may be of great inspirational value. He is the seer. He may be even halting in his speech, but by his ideas, his skill, or his manner of presenting the subject he may impress the stu-

dent with the greatness of the profession that he is studying and lead him on to larger visions. Fortunately, the world needs both draft horses and speed horses, otherwise some of them would have to be put out of the way. Similarly, it is a great comfort to some of us to think that possibly we are doing the work of the world for which we are created, even if we are not breathing out great ideas at every breath. All hail to the man, however, who has ideas and can cause others to adopt them, to lift the world up and into larger visions, and so to do bigger things for the benefit of mankind. Great men are not necessarily either enthusiastic or yet inspirational, and some of the poorest teachers under whom I have sat were great men in other lines of human endeavor. But I am sure we can all recall some one of our own teachers who was both a great man and a good teacher at the same time. But, may I not ask, was he not a good teacher because he was enthusiastic and inspirational, and had no thought of apologizing for being a teacher? The man who can never be a good teacher is he who is ashamed of his job, for to him it is most likely to be only the line of least effort to the pay-check.

The good teacher is he who has felt the thrill of having been called to the upbuilding of character in others, who day by day sees the unfolding of the innermost life of his fellow citizen, who has a life of service to live and enjoy, and who deals with human minds in the laboratory of life; for, after all, is not education only scientific research applied to character? Just as we go to the physician for improvement of the body, and to the priest for the betterment of the human soul, so we should go to the good teacher for the training in character which the young all need in different degrees. One of the inspiring sights of the college year and the one which always gives me a genuine thrill of happiness is on commencement day to look over the sea of upturned faces of men and women who have just been graduated and feel that we have been in some small degree a party to their training and responsible for their future success in the battle of life and in the part that they will hereafter play, for weal or for woe, as our fellow citizens in this republic. In their promise of success is our joy and reward for a year of hard work. But for the joy of service, some of us would not be willing parties to what the governor of Ohio recently described as "the scandal of low salaries paid to college professors." I sometimes think that school boards and trustees occasionally take advantage of the idealism of the teacher to get his services below the proper market rate; and this is especially true of engineering teachers who in most cases can, and sometimes do, earn more money from their clients during a part of the year than they receive from their professorship during the major portion of the year. All the pay of the good teacher does not come inside the pay envelope. Much of it comes in that inward consciousness of work well done in the training for citizenship, for that efficiency which will prevent poverty, for success in whatever walk of life may be followed, and finally for the larger life here and hereafter. Some one has defined the professional class as the one that has no leisure, as instanced by the minister, the physician and the lawyer. Judged by that standard, we, as teachers, belong to the professional class.

Probably some of you have been wondering why I have not as yet said anything about the good engineering teacher being above all other things a good engineer. That goes almost without saying in this presence, provided you mean the *best* teacher. The engineering teacher who has

never practised anything that he has taught, who has never seen built anything that he has designed, who has never prepared for an elaborate test of some plant or machine and found that he had foreseen all the various requirements in the way of labor, apparatus and equipment, even to the board and lodging of himself and his assistants, can not expect to be considered as yet a really good engineering teacher. However, it must be remembered that as this is an educational society, and not an engineering or a technical society, as Dean Charles H. Benjamin has so aptly put it, so it must be remembered that the colleges need men who to be teachers must be first able to impart their knowledge, draw out from their students all that is in them, and cultivate in them the habits of correct thinking, clear vision, active imagination, sound reasoning powers, and good judgment; and because they possess these things themselves and can train others in them, they are therefore fit to be counted among the good teachers. It is for these reasons that good engineering teachers are said to be more difficult to find than are good teachers of other subjects.

A good engineering teacher must know what engineering really is. He must have clearly defined ideas on what are the distinguishing features of engineering, technical, manual training, trade school and industrial educations. He must have no half-hearted ideas as to where the engineering trades stop and where the profession begins. He must not be afraid to get out into the deep water of the profession of engineering. He must not believe that the proper engineering education is strictly utilitarian and vocational, and not one bit cultural. He must look between the folds of the ancient armor of his colleague in the college of arts of his institution, and discover that the scientific spirit has largely superseded the literary spirit even in such subjects as Latin, Greek and the modern languages; that in fact in the work of some language teachers there is more of science than of language; that the so-called literary colleges are training men for vocations just as truly as are our colleges of engineering, law and medicine; that while the old-time classical colleges used to train men to be gentlemen, their successors in the educational world train men for journalism, insurance, politics, trade and business, as well as for education, the law and the ministry as heretofore. We engineers think that they are to be congratulated, in that they have enlarged their system of education and no longer make it so general as to fit the student for nothing in particular and so non-technical as to be useless except as a preparation for one of the professions.

"To know the best that has been thought and said in the world" is what Matthew Arnold calls culture. To the engineer, this is not the fullness of culture, but the rather to know the best that other men have thought, and said, and done. Even this is only half of the full duty of a cultured engineer. He should not only know the best that others have thought, and said, and done, but he should, as far as he may be mentally able, have contributed to the thought, and writings, and doings of the world. The engineering, above all other professions, demands that its members shall not be solely scholars, nor yet students of unsolved problems, but they shall have solved some of the problems which have pressed upon civilization for solution. Engineering teachers should be not scholars solely, nor yet students only, but pioneers and creators in the work of civilization. The first live in the spiritual palace called a library, where time, memory and the receptive faculties are alone required. The student lives in the laboratory where

the powers of observation are developed, logic reigns and laws are discovered. The successful engineer lives on the frontier of civilization, on the firing line of human endeavor, where those material problems have to be solved that have been set for the ages, and where the art of creation is wedded to the science of industry. The scholar deals with the past. The student lives in the present. The engineer looks into the future and solves its problems.

To be a good engineering teacher, one must be something of a scholar, student and creator and, highest of all, an educator capable of leading others to be the same. Such men are necessarily scarce, and while their financial rewards may be small, the satisfaction that they very properly get from their work transcends all their many self denials and enables them to hold their heads up with the world's best people.

This society was formed for the promotion of the kind of education which has been described. This is its twenty-first annual meeting. It may be now said to be of age. In closing this address I desire to leave with the next program committee and the incoming officers just two suggestions with the hope that they may be possible of adoption.

Let the program next year include a rousing session on "Education as a Science, rather than as an Art." Those of you who are familiar with the proceedings of the society know that we have had the subject of education considered as an art dealt with from many points of view. Until this meeting, little, if anything, has been done to consider the rationale and science of our chosen profession of education. Let the best minds in the educational world tell us, and in a practical way, all that time will permit concerning the science of education, including its psychology as applied to engineering education. Schools of salesmanship have their special courses in the psychology of their chosen vocation; but did any one ever hear of a course in psychology being demanded as a part of the necessary training required for the engineering teacher? As training and instruction in the normal school are required of grammar-school teachers, and as graduation from a college of arts or of education is expected or demanded from the would-be high-school teacher, and since successful courses are given in our colleges of education on how to teach mathematics, chemistry and physics, surely courses are needed on how to teach the applications of these subjects. Hence I claim that some professional training in education should be required of the man who desires to impart his knowledge and to train young men for the practise of the engineering profession. We are engineering educators. Why should we be required to possess much professional knowledge and training in engineering and none in education?

And this leads me to my last suggestion, which is that the faculties of some of those universities which maintain colleges both of engineering and of education should offer in their summer terms strong courses of study in psychology and in education considered both as a science and as an art. These should be conducted by their most virile and experienced men, and college presidents, deans and heads of departments should be requested to influence their younger assistants and fresh graduates who expect to go permanently into the work of education to take these proposed courses of study in the summer term in preparation for their work in the college of engineering in the succeeding year. If this is done, more engineering teachers will become engineering educators.

WM. T. MAGRUDER
THE OHIO STATE UNIVERSITY

PRACTICAL WORK IN SCIENCE TEACHING

MOST of us, and particularly those who are interested in teaching some one special branch of learning, are likely to forget that the great aim of all educational processes is to uplift and benefit humanity; and are likely to hold an exaggerated opinion of the value of our special branch in the general scheme of education. This view is perhaps natural and justifiable, since without it enthusiasm could not exist and teaching would lose much of its pleasure. The breaking away from the older forms of stereotyped abstract forms of education where a somewhat narrow point of view was so long held came in response to a demand that men be free to study *all* forms of natural phenomena living or lifeless and to draw therefrom spiritual inspiration or bodily sustenance as might be available. This movement was greatly aided and hastened by the fact that the conclusions drawn from the study of natural phenomena were of direct use in industry. They were to a large extent, and are still, the result of industrial demands and in so far as they answer these demands they have been of tremendous assistance in affording better support to human life, which after all is the great central problem. In later years this movement has been further strengthened by the discovery that the study of natural phenomena led to a certain form of mental training that afforded a powerful means of attacking abstract problems. The term "scientific method" has come to mean a somewhat definite way of approaching the solution of all problems as opposed to older and so-called empirical methods. And at the same time it has appeared that this same study of things mundane, if properly conducted, actually bestowed upon the student thereof a certain amount of general or liberal training, greater perhaps than the adherents of the old school would admit, and less perhaps than the more ardent advocates of the new methods usually claim.

From time to time we are warned by educational reformers that education to be effective must be kept close to the ground, and must draw its inspiration from the life of the community it tries to serve. Education *is* life and not merely preparation for life, and all forms of educational effort that ultimately survive will be those that in some way throw light on the current problems of existence. That this is so can not be doubted by any one that has noted the changed point of view of many of the older forms of educational effort. History is no longer a mere chronological record of kings and battles, but is rapidly being vitalized into a lesson for the future by *analyzing* the records of the past; and the classics themselves will not reach their highest development and usefulness till they are interpreted by their sponsors, not as the dry and dusty records of past ages, but as vital lessons in the mainsprings of human thought and action. In no document that I know of has this point of view been so clearly and concisely expressed as in the Morrill act. the foundation of our state colleges of agriculture and the mechanic arts, which states that "the leading object of these colleges shall be, without excluding other scientific and classical studies and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts in such manner as the legislatures of the states may respectively prescribe in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life." Truly this document may well be called our declaration of educational independence and is worthy of the careful perusal of every teacher.

In the general truth and expediency of these principles most of us are fully agreed. In fact in these days when industry is the idol, not only of our own, but of all other progressive nations, they hardly admit of argument. The teaching of so-called practical courses holds an assured place. But apparently the influence of heredity runs strong in our veins, and no sooner do we lift the study of a practical subject from the realm of empiricism to a scientific basis, than we begin to codify, classify and tabulate its scientific basis, mathematically, chemically and physically. This is a natural and correct thing to do, as it is

the most accurate and most convenient way to express and record the principles of the phenomena that we have studied. It is also the best way in which these principles can be expressed to be of service in future investigations and to scientific men generally. But in our enthusiasm over our specialty we are prone to forget some of the foregoing principles. We are likely to forget that men come in different sizes and grow to different heights; we may forget that the requirements and *capabilities* of the scientist and the plain every-day man are vastly different in *character,* though perhaps not so different in *degree.* As a matter of fact, our public school system is founded on the supposition that all men are born equal in opportunity as well as in an intellectual sense, which is far from being a reality. The result is that most of our educational processes tend to grow away from industry and the soil and the preparation of those that are to labor in the more humble callings and to take cognizance only of those who are, presumably, to occupy the higher positions. No thinking man can doubt the supreme importance of training leaders; it is hardly a debatable question. But in so doing we should not forget that in these days intelligent leadership is useless or at least greatly handicapped without intelligent followers; and our educational methods should take cognizance of *all* kinds of men, keeping in mind that the vast majority of these will always be found in the ranks of the followers.

So there has lately grown up a sentiment that our science teaching is drifting away from the close contact it should have with life and democratic education. We are confronted with the strange charge that our science courses, formerly looked upon by the classical scholar as the very essence of things practical, are no longer practical. We are told that they are neither life itself nor preparation for life. We are told that just as the older educational methods erred in supposing that the repeating of words and the observance of forms produced educated men, so we are likely to mistake the shadow for the substance in expecting to send out men trained in the scientific method and filled with the scientific spirit simply because they have worked over and perhaps memorized certain standard forms of mathematically expressed scientific laws. In other words, we are charged with transferring the error of the older methods to new fields, and the cry has gone forth that science teaching must be again vitalized, that it must be made more practical and brought back close to the industries whence modern science sprung. Most of us will admit freely that there is some truth in these assertions, particularly as regards the failure of our highly developed science courses to take cognizance of the needs of the great mass of men and women who go no further in academic work than the end of the high school course. The majority of them do not engage in callings where expert scientific knowledge is an essential. Yet all should have some scientific training, first to acquire, if possible, the scientific method of attack, because this is the weapon with which we have made ourselves masters of physical things, and second that they may be reasonably intelligent regarding the natural phenomena that surround them on every hand with ever increasing complexity. There is no doubt that high school science can be made more effective for the great mass of the people by making it somewhat less formal, and bringing it closer to the lives of the plain people.

But before we proceed far with our reformation it may be well to define first just what we mean by *practical scientific education.* Do we mean (1) the giving simply of descriptive information and explanations of every-day phenomena; or do we mean (2) the using of these every-day phenomena to interest the student in rediscovering the laws that underlie them; or again do we mean (3) the application of these rediscovered principles, formally expressed, to practical every-day problems in sufficient degree to secure to the student ability to handle the formal mathematical statement of these principles in an easy and confident manner.

A very cursory examination of college and high school curricula will show that all three of these progressive steps are in common use.

I have in mind a certain course given in a certain college, that shall be nameless, that is strictly of the first kind. It is eminently practical and I believe it is as eminently useless as far as mental development is concerned.

This interpretation of practical education is common and the inadequateness of this form of instruction *taken by itself* is so glaring when compared with some of the old and much-maligned classical methods as to make one pause and wonder. Yet there are, as we shall see, places in our educational structure where such courses are not only desirable but necessary. The error comes in assuming that they are sufficient unto themselves as educational tools.

The second interpretation forms the basis of the arguments presented by some of those who would reform our high school science teaching. The claim is made, and with good reason, that the interest of the student is much more readily secured through familiar *visualized* physical phenomena than through the abstract mathematical statements of the underlying principles. Once his attention and interest are secured, it is easy to lead him to investigate and rediscover these laws, thereby acquiring a general knowledge of the phenomena and also the scientific method of approach which should be of use in attacking the many other problems of his life. Or, as Professor Mann[1] has expressed it, the present order of procedure is usually: principle, demonstration, exemplification in laboratory, application; while the newer ideas would make the order: application, problem, solution in the laboratory, principle. Professor Mann's reasoning for this order is based on his definition of the benefits to be derived from the study of physics (and the same argument holds for all other fundamental sciences). These benefits he says are of two kinds; they consist of (1) useful knowledge of physical phenomena; (2) discipline in the methods of acquiring this useful knowledge. No fault can be found with this statement as far as it goes and, as will be shown, there are parts of our educational structure where this form of instruction, like the former one, is not only justifiable but sufficient. The error again is in assuming that this order of procedure forms an educational basis sufficient for all men and all forms of study. Let us see where this reasoning will carry us.

As this writer himself points out, knowledge of physical phenomena and discipline in acquiring it may be either *specific* or *general*, and specific knowledge and training acquired by studying some special field becomes more and more useful as it becomes more and more general by being used and interwoven with a wide range of experience. This is true not only of scientific studies, but of all forms of educational effort. Let us then apply this new theory to the teaching of some simple fundamentals such as reading and spelling, where, incidentally, the method of approach advocated is already well developed. By means of the common objects of the child's environment he soon is taught the principles of reading and spelling and may acquire not only much information regarding these objects, but a considerable mental development in attack, with a considerable knowledge of the principles involved in reading and spelling. But he is still a long way from being able to either read or spell even after these principles have been made evident to him. He must now *apply* these principles long and tediously before he can master this fundamental study. This is even more marked in mathematics. Approach through applications, demonstrations and investigation to secure data, and the discovery of the principles involved are not sufficient. To use these principles freely requires long and close application of them, and while this labor may be made more interesting by using practical problems, there is a *quantitative* element that can not be overlooked. This is very clearly instanced in the case of factoring in algebra. Many cases of a similar kind may be cited even when the processes are manual in their character. It is easy, for example, to approach the making of good letters and figures through the making of mechanical drawings of some familiar object that the student is interested in. But even after the student

[1] "The Teaching of Physics," p. 213.

sees the application and need of good letters and figures, and even after he has had the theory of any good system of lettering carefully expounded, he will never make good characters till he has toilsomely applied that theory many, many times. Again we may awaken the interest of the student in, say, the art of planing wood with a hand plane by showing first the principles of power planing machines and then the construction and principles of hand planes. But he will never master the use of the instrument except through persistent and often toilsome effort, even though that effort be made interesting by application to practical problems. And the general principle is true of all fundamental work, mental or manual, that the student expects to build upon for the future. There is a tremendous difference between knowing a lot about general physical phenomena with the methods of finding the principles involved, and the power to use the formal statements of these principles in attacking other problems. And while, as before stated, it may sometimes be desirable and sufficient to stop at the end of the first or second stage noted above, care must be exercised that this is not done in any subject where the accurate and confident use of the formal principles rediscovered are essential to future progress. Evidently this applies to the teaching of all elementary fundamental subjects, but the dividing line may perhaps be made more clear by studying the problems presented in so-called industrial education, which is very likely to be effected by this new movement.

Aside from inherent ability and general or liberal knowledge the accomplishments that industrial workers must possess are of three kinds: (1) Manual skill; (2) industrial or manufacturing knowledge; (3) scientific knowledge and the ability to *use* it. The first is self-explanatory. The second refers to the knowledge of shop processes and methods of manufacturing and the finance and economics of production. The first two may be partially acquired in schools, but as a general principle their full attainment must be acquired in the atmosphere of the shop or factory. The third refers to the knowledge of the natural scientific laws that may, in general, be acquired from books better than from actual shop work. Now the position which an industrial worker may occupy is governed by the relative amount of these three accomplishments that he may possess. Thus a good tool-maker must possess a certain amount of scientific knowledge and must possess a maximum of manual skill. The shop manager must possess a certain amount of scientific background but must be highly informed regarding manufacturing methods. The engineer must have some manual skill and shop knowledge and must be well grounded in scientific principles and their application. It is important to note that he must not only have a general knowledge of the scientific phenomena on which his work is based, but he must be able to *apply* their formal mathematical expressions freely and accurately. Superficial knowledge is not enough. In his most highly developed form the engineer must pass out of the realm of visualized principles and reason with abstruse, abstract scientific phenomena far removed at times from the practical. The ability to do this requires not only a full knowledge of principles but an ability to use them that can come only from long and persistent practise. And it is to be especially noted that the foundation of this ability must be laid in the school. Time was when a bright man could easily acquire in the shop the scientific background required for any engineering work. The complexity of modern engineering has, however, changed all this and the man who is to rise to any height in the field must in general acquire this scientific background before he enters it. *Men seldom add to their scientific base line after leaving school,* and the height to which they rise along scientific lines is measured almost absolutely by the amount of solid scientific training they take away from the school. This is not dogma, but history, and can be easily verified by any one. It is particularly true of the electrical engineer and similar industrial workers in the higher levels of industry.

But *all* the courses offered to the embryo electrical engineer need not be of the searching character indicated by the above. Thus

his principal work in life may be "buttressed" and made more effective by a course in steam engineering, for instance, that goes no further than the second stage mentioned above. It is sufficient if he knows the *forms* of steam apparatus and the general principles underlying their construction without ever applying these principles to design or investigation. On the other hand, the steam engineer and civil engineer are rounded out and their work made more effective by a course in the forms and characteristics of electrical machinery without going into the rigid application of the fundamental principles involved. It thus appears that we may with good logic stop at either the first or descriptive stage or at the end of the second or experimental stage of a given line of instruction, provided we properly interpret the effect; but for fullest mental development and ability to make practical use of the theory involved the process must be continued through the phase of thorough mathematical application.

What is true of the college is true also of the secondary school. When we have fully developed our secondary school system we shall have several, if not many kinds of such schools. The preparation of the few going to engineering colleges will be conducted more and more along the lines of general or humanistic studies. They will study fewer courses and will study them more thoroughly. For the many going out into the world from the high school we shall have, as before stated, several kinds of schools all with vocational direction and some of them plain trade schools. Each one of these schools will have a central course or courses carried as far as possible through the third stage, and these central courses will be strengthened and buttressed by other practical or scientific courses that will be stopped not later than the end of the second stage. Some of these central courses will be very practical and some more mathematically scientific than we may perhaps imagine. For industry tends to become more scientific and as a consequence more mathematical. If one doubts this he should look carefully into the mathematical work involved in reducing to workable form, Mr. W. F. Taylor's[2] experiments in the very practical study of the laws underlying the cutting of metals. It required high mathematical attainment to solve what might seem at first to be a simple practical problem, and to-day many workmen in this country are doing such extremely practical work as setting the cutting speeds and feeds of machine tools by means of slide-rules the mathematical basis of which is far beyond their conception. And these same general observations and principles will apply throughout the entire range of vocational education. This, I believe, is the true interpretation of this new movement.

There *is* a place for courses much more practical and more attractive to the student than those built solely along mathematical lines. But do not let us delude ourselves that this idea constitutes a complete new educational scheme. In this connection it is well for us to remember the history of some of the educational reform movements we have already witnessed. When we tore away from the old classical form of education it was firmly believed that we could build up an educational edifice that would give as good, if not better results, not only as regards mental development, but as regards general training and outlook on life. It is interesting to note that the engineering colleges, that have benefited by this separation as much if not more than any other form of educational activity, long ago realized that we can not profitably throw away human experience and have already begun to swing back and more and more to build their work on the humanities as a sure foundation. When the broadly elective system was brought forward it was heralded as the final solution of educational problems, but already we have evaluated its influence and adopted it partially, only, in the form of elective *groups* of study. And so this new movement in science teaching can not disregard human experience. No power of concentration and no mental development worth while can ever come about except by hard and unremitting toil. We may

[2] See *Trans. American Society of Mechanical Engineers*, Vol. 28.

sweeten the dose, but to be fully effective the student must swallow it all, including the rigorous drill that can come only from the many applications that must be made before the benefit becomes an integral part of his personality.

And I am not so sure that we may not do some harm by oversweetening the dose. The theory that there is no pleasure in abstract mental effort is in my opinion more or less of a fallacy. There is a certain satisfaction that comes from successful effort, whether the work accomplished be abstract or practical. Students are naturally more interested in practical than in theoretical matters, and a teacher lacking in inspiration can very well help his work by a careful choice of illustrations. But to the student who sits under a teacher whose instruction is illuminated by the "divine spark" all things are interesting, whether they be music or logarithms. Let us not confuse *mechanism* with *inspiration*. Furthermore, it is a good thing for boys and girls to be compelled to do a certain amount of uninteresting if not unpleasant work. The duties of life are not, on the whole, entirely pleasant; and since proficiency in overcoming obstacles is obtained only by overcoming a few, perhaps a little uninteresting work is a good thing, after all. Huxley says, "the best way to learn how to do a thing is by doing something as near like it as possible, but under easier and simpler conditions." There is no royal road to learning; and if the three R's are the basis of our educational methods, so the way of mastering them and attaining the mental heights their mastery leads to lies through the three T's. No high mental development ever has or ever will be accomplished without a liberal application of toil, trouble and tears.

Dexter S. Kimball

January 17, 1913

THE MINING CONGRESS AND EXPOSITION IN PHILADELPHIA

Manufacturers of mining machinery, rescue and first-aid apparatus and safety appliances are to be given an opportunity to display their wares before the mining men of the country at an industrial exposition to be held under the auspices of the American Mining Congress, in Philadelphia, Pa., during the week of October 20.

This exposition, the first of its kind in this country, will be held in conjunction with the annual convention of the Mining Congress. It will be national in scope, the metal mining interests of the west to be as fully represented as the coal mining of the east. There is a tentative plan to have a gold mining camp in full operation with a mill crushing the ore. Horticultural Hall, situated in the heart of the city, has been engaged for the occasion.

While the plans are still in embryo, a number of the leading manufacturers have already been approached and have shown sufficient interest to lead to the belief that all the space will be taken.

A number of the large coal companies that have developed the "safety first" movement at their mines are arranging for space to show the mining men and the public what they are doing in behalf of their men. These companies will send rescue and first-aid crews and there is talk of exhibition drills between the various crews. The U. S. Bureau of Mines will be represented by one of its safety cars and a picked crew of helmet men. The state of Illinois and a number of the anthracite companies may send rescue cars for exhibition purposes.

The convention is the first to include all the mining interests of the country and an attempt is to be made to show the need of a stronger national organization that will represent all phases of the industry. Perhaps the leading topic of the convention will be the new system of mine taxation recently put in operation in some states and being discussed in others at the present time. It is expected that a definite policy toward Alaska from congress will be asked.

The smelter fume problem will be discussed with the hope that an amicable adjustment may be reached soon. California has, at the present time, two commissions considering this problem and Montana, one.

The disposal of debris from placer mining is

another question that will be discussed by western men. They will declare that the placer mining industry of California has been nearly wiped out through drastic rules and regulations, some of them imposed by the U. S. government. At the present time the debris question is in charge of a commission of the United States army engineers and it is claimed that while they zealously watch the interests of the farmers, they know nothing about the mining problem. A demand may be made for the inclusion of a mining engineer on this board to see that the interests of the mines are protected.

The coal men of the east will be mostly interested in two problems, the "safety first" movement and the conservation of the coal lands adjacent to the great eastern industrial centers. This latter, it is said, has become a question of most serious moment. It is fully realized by the eastern men that their coal fields are being used up at a tremendous rate and that when these coals are gone, it will be useless to think of getting coal from the west, for the commercial prosperity of the east depends upon a supply of coal at reasonable price and transportation charges from the west would be too great.

The proposed system of leasing mineral lands will also come up for extended discussion. The fact that the federal government some time ago leased coal lands in Wyoming to a coal company, thus making the entering wedge in this system of disposing of the government's mineral lands, will undoubtedly call for comment. Then there is the proposal for the revision of all the mining laws of the country. A great many mining men are of the opinion that the laws are antiquated and cumbersome, imposing hardship upon every one who has to deal with them.

MEMORIAL TO SIR WILLIAM LOGAN

On July 16, in the little fishing village of Percé, on the Quebec shore of the Gulf of St. Lawrence, a memorial was unveiled to Sir William Edmond Logan, Kt., LL.D., F.R.S., founder and first director of the Geological Survey of Canada. The day selected for this interesting event was the occasion of the visit of seventy members of the International Geological Congress to the Gaspé country and the memorial was erected by the Congress to commemorate the important official services of Sir William Logan which began in Gaspé in 1842. Though the day had been set apart for the exploration of the picturesque and involved geology of Percé, a half hour was appropriately devoted to the ceremony of effectively reminding the visitors who it was that first lifted the veil from the geological problems of Gaspé. The memorial is a bronze slab bearing a strong and effective medallion portrait of Sir William accompanied by a suitable inscription and is the highly artistic work of Mr. Henri Hébert, of Montreal. It has been attached to the face of a natural rock wall in the heart of Percé village. At the unveiling ceremony suitable addresses were made by Dr. A. E. Barlow, chairman of the Logan Memorial Committee, and by Dr. John M. Clarke. As a further expression of their desire to establish the memory of Logan and his work in Gaspé, and to acknowledge their appreciation of the extraordinary attractions of Percé, the committee contemplates acquiring the land about the present memorial in order to present it to the town as a public park.

SCIENTIFIC NOTES AND NEWS

The Kelvin Memorial window in Westminster Abbey was dedicated on July 15. The dean of Westminster made the address and the ceremonies were attended by many distinguished scientific men. The window, which was designed by Mr. J. N. Comper, is in the east bay of the nave on the north side. The light from it falls upon the graves of Kelvin and Isaac Newton, and immediately beneath it are the graves of Darwin and Herschel.

A committee has been formed to erect a memorial in honor of the late Sir William White, the distinguished naval architect, at the time of his death president of the British Association for the Advancement of Science.

Former students of Ralph S. Tarr, of Cornell University, wish to place on the campus

a permanent memorial of his work. They have thought that a suitable memorial would be a boulder carved so as to form a seat and bearing an inscription. If a boulder is found that can be brought to the campus it will probably be placed on the brow of the hill near McGraw Hall, where Professor Tarr taught physical geology for twenty years.

LORD AVEBURY has bequeathed one thousand pounds to the University of London to found a prize in mathematics or astronomy in memory of his father, Sir John William Lubbock, first vice-chancellor of the university.

A NUMBER of the friends of the late Samuel Franklin Emmons have presented to Columbia University a memorial fund for the endowment of the "Emmons Geological Fellowship," the purpose being to continue, through investigations and publications, the scientific research carried on by Mr. Emmons during his lifetime, more particularly in the field of economic geology. The fellowship will be awarded from time to time to graduates of any college or university who show exceptional capacity, by a committee consisting of Professor James F. Kemp, professor of geology in Columbia University; Professor John D. Irving, of the Sheffield Scientific School, Yale University, and Professor Waldemar Lindgren, of the Massachusetts Institute of Technology. The recipient will be at liberty to travel and to conduct his investigations either in this country or abroad.

BY the will of the Rev. L. C. Chamberlain, who died at Pasadena, Cal., on May 9, $25,000 is bequeathed to the Smithsonian Institution for its mineralogical collections, and $10,000 for its collection of mollusks. There was also bequeathed $5,000 to the Academy of Natural Sciences in Philadelphia for increasing and maintaining the Isaac Lea collection of Eocene fossils. These bequests were made for the benefit of the scientific work in which Isaac Lea was interested, Mrs. Chamberlain having been the daughter of Isaac Lea and having inherited the money from him. Mr. Chamberlain also bequeathed $100,000 and his residual estate to the Thessalonica Agricultural and Industrial Institute, Turkey.

AMONG the degrees conferred by the University of Michigan at its recent commencement was the degree of doctor of laws on Dr. John Dewey, professor of philosophy at Columbia University, and the degree of doctor of science on Dr. Ludwig Hektoen, professor of pathology at the University of Chicago; on Dr. Lafayette B. Mendel, professor of physiological chemistry in the Sheffield Scientific School of Yale University, and on Dr. Armin O. Leuschner, professor of astronomy and dean of the graduate school of the University of California.

ST. ANDREWS UNIVERSITY has conferred its doctorate of laws on Dr. G. A. Boulenger, of the natural history department of the British Museum.

DR. HARRY C. JONES, professor of physical chemistry at the Johns Hopkins University, has been awarded the Edward Longstreth medal of the Franklin Institute of Philadelphia for his work on the nature of solutions.

PROFESSOR VON WASSERMANN has been appointed head of the newly-established Kaiser Wilhelm Institute for Experimental Therapeutics, one of the laboratories founded by the Kaiser Wilhelm Society for Scientific Research.

MR. C. W. MASON, of Wye, England, and Mr. Donald McGregor, of Oxford, have been appointed Carnegie scholars in entomology under the Imperial Bureau of Entomology. Mr. Mason arrived in the United States early in July and is now studying at the laboratory of parasitology of the Bureau of Entomology of the U. S. Department of Agriculture at Melrose Highlands, Mass. He will study in this country for one year. Mr. McGregor will arrive in New York soon and will probably join Mr. Mason at Melrose Highlands.

IN accordance with the decision of the council of the American Association for the Advancement of Science, Dr. Robert M. Ogden, of the University of Tennessee, has been appointed by the committee in charge of making the selection of the temporary asso-

ciate secretary of the American Association to further the interests of the association in the south and to promote the meeting to be held next winter at Atlanta, Georgia. Dr. Ogden will enter upon his duties the first of next October.

Mr. F. P. Gulliver, as geographer of the Chestnut Tree Blight Commission of Pennsylvania, is studying the relation of soil and climate to the growth of chestnut trees and the spread of the blight.

Mr. O. E. Jennings, of the Carnegie Museum, Pittsburgh, is engaged in a botanical expedition to the north of Lake Superior to study the ecological distribution of plants.

Professor W. M. Davis, of Harvard University, delivered two lectures before the students in geology and geography at the summer session of Columbia University, on "The Mountains of the Great Basin" and "Principles of Geographical Descriptions." Professor G. A. J. Cole, director of the Geological Survey of Ireland, addressed them on "Ireland, the Outpost of Europe."

Director Charles E. Thorne, of the Ohio Agricultural Experiment Station, gave an address on July 15, at the University of Illinois, on "The Relation of Cattle Feeding to Soil Fertility." The occasion was the attendance of 250 cattlemen to inspect the baby beeves that had just completed a 210-day feeding experiment.

Dr. Robert von Lenderfeld, professor of zoology and director of the Zoological Institute in Prague, has died at the age of fifty-six years. Dr. von Lenderfeld's numerous and valuable publications in zoology, especially those on the morphology and classification of sponges, are well known. At the time of his death he was rector of the German University in Prague.

Civil service examinations are announced as follows: chief in the Office of Information, Department of Agriculture, Washington, at $2,500 a year; bacteriologist at a salary ranging from $1,800 to $2,000 a year in the New York food and drug inspection laboratory, Bureau of Chemistry, Department of Agriculture.

The minister of public instruction of Argentina has authorized the preparation of an expedition from the National Observatory at Córdoba to observe the total solar eclipse which will occur on August 20–21, 1914. The expedition will be composed of three members of the observatory staff, with an extensive equipment of instruments and will proceed to a point (as near to the central line as possible) in southern Russia, not far from the Black Sea. It is expected that the expedition will be joined by astronomers from the Berlin, Potsdam and Koenigsberg observatories.

Secretary Houston has announced that hereafter the Department of Agriculture will send a weekly letter to the correspondents of the department, giving the latest agricultural information of value to the farmer. The letters will treat of crop conditions and prices, the discovery of new plant or animal pests, pure food decisions, and those which affect users of irrigated land and the national forests, and any other work of the department which can benefit the farmer. The letter is to be sent weekly, so that the news may reach the farmers promptly. The *Crop Reporter,* a monthly publication which has been issued by the department for some years past, is to be discontinued, Secretary Houston having decided that it reached the farmers too late to be of any practical use.

The first annual meeting of editors of publications of agricultural colleges in the middle west was held at the University of Illinois on July 10. Representatives of six states met and discussed informally the problems in connection with the gathering, editing and publication of agricultural material. It was voted to hold a session in 1914, to which many other states will be invited. The association elected Dr. B. E. Powell, of Illinois, executive secretary to make necessary arrangements for the next meeting.

Following is the New York Botanical Garden's program of late summer lectures, which will be delivered in the museum building,

Bronx Park, on Saturday afternoons, at four o'clock:

August 2, "American Desert Plants," by Dr. William Trelease.

August 9, "The Biology of Cheese," by Dr. Charles Thom.

August 16, "Wild Flowers of the Late Summer," by Dr. N. L. Britton.

August 23, "Explorations in Mexico, II.: Mexico City to Cuernavaca," by Dr. W. A. Murrill.

August 30, "The Mammoth Trees of California," by Dr. Arthur Hollick.

September 6, "Shade Trees and their Enemies," by Dr. F. J. Seaver.

September 13, "A Visit to the Panama Canal Zone," by Dr. M. A. Howe.

September 20, "Scenic and Botanical Features of Devil's Lake, Wisconsin," by Dr. A. B. Stout.

September 27, "Explorations in Mexico, III.: Colima and Manzanillo," by Dr. W. A. Murrill.

ARRANGEMENTS have been made between the New York State College of Forestry at Syracuse University and the Palisades Inter-State Park Commission whereby the College of Forestry will prepare and carry out a plan of management for the 14,000 acres of forest land controlled by the commission and lying along the Hudson River. The work of getting the forest land into shape will be started about the middle of August by four advanced students under the direction of Professor Frank F. Moon, of the College of Forestry, who was forester for the former Highlands of the Hudson Forest Reservation. The various properties will be mapped out and studied to ascertain the amount of the timber now standing and the amount to be removed. In addition, the fire problem will be studied and eventually a long term reforestation plan put into force. Centers of insect and fungus damage will be located and timber will be marked so that during the coming winter the park employees will be busy removing the dead, diseased and undesirable specimens. A forest nursery will be developed and active reforestation begun in 1914.

THE national congress of Brazil has passed and the president of that republic has approved a law fixing legal time in Brazil. Following is a translation of the bill:

Art. 1. For purposes of international and commercial contracts the meridian of Greenwich shall be considered fundamental in all Brazil.

Art. 2. So far as the legal hour is concerned Brazilian territory is divided into four distinct zones as follows:

(*a*) The first zone includes the archipelago of Fernando de Novorha and the island of Trinidad, and shall have Greenwich time "less two hours."

(*b*) The second zone includes all the coast, all the states of the interior (except Matto-Grosso and Amazonas), and the part of the state of Para east of a line starting from Mount Grevaux on the frontier of French Guyana, following down Rio Pecuary to the Javary, along this last river to the Amazonas, and southward along the Rio Xingu to the state of Matto-Grosso. This zone shall have Greenwich time "less three hours."

(*c*) The third zone includes all of the state of Pará west of the line just mentioned, the state of Matto-Grosso, and all of the state of Amazonas east of a line drawn on a great circle starting at Tabatinga and ending at Porto Acre. This zone shall have Greenwich time "less four hours."

(*d*) The fourth zone includes the territory of Acre and the region west of the line just mentioned, and shall have Greenwich time "less five hours."

THE following letter from President John C. Branner was published in the *Journal do Commercio*, Rio de Janeiro, June 14, 1913:

The first volume of the "Monographs of the Geological and Mineralogical Service of Brazil" has just appeared, published by the Ministry of Agriculture, Industry and Commerce. It bears the title "Devonian Fossils of Parana, by Dr. John M. Clarke," Rio de Janeiro, 1913.

It is a work of the greatest importance to science, not only that of Brazil, but of the foreign world as well.

The Federal Geological Service has been in operation in Brazil for six years. In this relatively short time the director has, amongst many other achievements, succeeded in bringing together an important collection of Devonian fossils of the highest interest to science and in inducing Dr. Clarke, the official geologist of the state of New York and one of the highest authorities on this subject, to undertake their study, description and discussion. In the words of Dr. Clarke himself, "the results are of world-wide import." The interest and importance of this monograph are due, in great part, to the fact that the studies embrace,

aside from the Devonian fossils of Parana, those of Matto-Grosso, the Amazonas [Argentina] and the Falkland Islands, while the general conclusions extend to the Devonian of all the continents of the world.

The text of this monograph, in Portuguese and English, covers 353 pages, which are accompanied by 27 handsome plates printed in Germany by the most advanced processes of the lithographic art.

This fine work as a contribution to pure science does honor to the author, to the director of the Geological Service, to the Ministry of Agriculture and to the country.

THE composition and characteristics of the population of Hawaii, as reported at the Thirteenth Decennial Census, are given in a bulletin soon to be issued by Director Durand, of the Bureau of the Census, Department of Commerce. It was prepared under the supervision of Wm. C. Hunt, chief statistician for population. Statistics are presented of number of inhabitants, increase and density of population, proportions urban and rural, race, nativity, parentage, sex, age, marital condition, place of birth, males of voting and militia ages, citizenship, year of immigration of the foreign-born, school attendance, illiteracy, inability to speak English, and number of dwellings and families. A previous population bulletin for Hawaii gave the number of inhabitants by counties and minor civil divisions. That and the forthcoming bulletin cover all the principal topics of the population census except occupations and the ownership of homes. The population of Hawaii at each census from 1832 to 1910, inclusive, was as follows: 1832, 130,313; 1836, 108,579; 1850, 84,165; 1853, 73,138; 1860, 69,800; 1866, 62,959; 1872, 56,897; 1878, 57,985; 1884, 80,578; 1890, 89,990; 1896, 109,020; 1900, 154,001, and 1910, 191,909. Racially the population of the territory is extremely heterogeneous. In 1910 the pure Caucasian element numbered 44,048, constituting 23 per cent. of the total population. Of this class, which is itself composed of diverse racial elements, 22,301, or slightly more than one half, were Portuguese; 4,890 were Porto Rican; 1,990 were Spanish, and 14,867 were of other Caucasian descent. The Japanese, numbering 79,675, constituted 41.5 per cent., or more than two fifths, of the total population, while the Japanese, Chinese and Koreans combined, numbered 105,882, or 55.2 per cent., of the total population. Persons of pure native Hawaiian stock numbered 26,041 and constituted 13.6 per cent. of the population. In the decade 1900–1910 the number of Caucasians in the population increased 15,229, or 52.8 per cent., the percentage of increase for this race being practically the same in this as in the preceding decade. The increase of the Japanese in the decade 1900–1910 was 18,564, or 30.4 per cent. In the same period the Chinese decreased 4,093, or 15.9 per cent. The number of pure Hawaiians decreased from 34,436 in 1890 to 26,041 in 1910, the decrease in the decade 1900–1910 being somewhat less than that in the preceding decade—3,758, or 12.6 per cent., as compared with 4,637, or 13.5 per cent. Slightly more than one half (98,157, or 51.1 per cent.) of the population in 1910 was native, and slightly less than one half (93,752, or 48.9 per cent.) foreign born. The native element embraces all persons born in Hawaii, or in any state or outlying possession of the United States. Persons born in Porto Rico or in the Philippine Islands, whether of Porto Rico, Filipino, or other racial origin are accordingly classified as native. For the Japanese the percentage native was 25; for the Chinese, 33.2; for the Portuguese, 61.7, and for the "other Caucasian" element, 66.7.

UNIVERSITY AND EDUCATIONAL NEWS

THE board of trustees of the University of Illinois at a recent meeting voted to reopen the college of dentistry which was closed in 1911 because of no appropriations. Doctor Frederick B. Moorehead, of Chicago, was appointed dean of the new dental college. The principal items in the new building program for the immediate future are: An addition to the chemistry laboratory, costing $250,000; an extension on the commerce building, costing $125,000; a school of education building, costing $120,000; a woman's residence hall, $100,000; another engineering building, costing $100,-

000; completion of armory, $90,000; a boiler house, $45,000; addition to the natural history building, $65,000; ceramics building, $65,000; addition to library and horticultural buildings, $48,000; stock judging pavilion, $30,000; for an extension of the present university campus and for an enlarged agricultural building, $400,000 was voted.

M. PIERRE BOUTROUX has accepted a professorship of mathematics at Princeton University, and will assume his duties in the autumn. M. Boutroux is a son of the distinguished professor of philosophy, M. Emile Boutroux, and is closely related to the Poincaré family.

DR. R. E. MCCOTTER, instructor in anatomy in the University of Michigan, has been appointed professor of anatomy at Vanderbilt University.

MR. FREDERICK DUNLAP, assistant in the forest service, physicist at the Forest Plant Product Laboratory and lecturer in the University of Wisconsin, has been elected professor of forestry in the University of Missouri.

THE following appointments have been made at Northwestern University: Edward Leroy Schaub, Ph.D., of the University of Iowa, to be professor of philosophy William H. Coghill, M.E., to be assistant professor of mining and metallurgy; William Logan Woodburn, Ph.D., to be assistant professor of botany; Elton J. Moulton, Ph.D., to be assistant professor of mathematics; Charles Ross Dines, Ph.D., to be instructor in mathematics; George Leroy Schnable, M.A., to be instructor in physics; Paul Mason Bachelder, M.A., to be instructor in mathematics; Harlan True Stetson, M.S., of Dartmouth, to be instructor in astronomy; Gilbert Haven Cady, M.S., of the University of Chicago, to be instructor in geology and mineralogy.

DISCUSSION AND CORRESPONDENCE

THE WORD "SELVA" IN GEOGRAPHIC LITERATURE

I WISH to enter a protest against the use of the Portuguese word "selva" as applied to the forests of the Amazon Valley in geographic literature. I am under the impression that the word was formerly used by several writers, but that it has been pretty generally dropped of late as unnecessary. This is written away from my library, however, and it is not possible to verify this statement at present.

In Mr. James Bryce's late book, "South America; Observations and Impressions, New York, 1913," the word "selva" is used as if it were not only the every-day and generally accepted name of certain and particular Brazilian forests, but as if it were so descriptive, so characteristic, and so appropriate that no English word could take its place.

I quote a few of Mr. Bryce's expressions:

> The great Amazonian low forest-covered country—the so-called Selvas (woodlands) (p. 168). The great central plain of the Amazon and its tributaries which the Brazilians call the Selvas (woods) (p. 555). The Selvas or forest-covered Amazonian plain (p. 558).

I regret to have to say that I know of no reason whatever for such a use of the word *selva.* In the first place, it is not the word used in Brazil either for the Amazonian forest or for any other forest, Mr. Bryce to the contrary notwithstanding. It is true that it is a good Portuguese word, but it is not in common use, and during the forty years I have been acquainted with Portuguese language I doubt if I have heard it used by a Portuguese-speaking person more than two or three times, and then only in a poetic sense.

The Brazilians speak of the forests of the Amazon as *mattas,* just as they speak of the forests of any other part of the country. In 1907 Dr. H. von Ihering, director of the Museu Paulista in S. Paulo, Brazil, published a paper in Portuguese on the distribution of Brazilian forests. The occasion certainly seemed to offer an opportunity for saying something about the "selvas" and their peculiarities, but I do not find the word "selva" used once in the 53 pages of that article. The forests are there either designated by the special names used in the country, or they are called *mattas, mattos* or *florestas,* which are the words in common use all over Brazil.

Besides its use in Mr. Bryce's book, I find "selvas" mentioned in E. W. Heaton's "Scientific Geography; South America," London (1912), at pages 17, 39 and 55. Elsewhere in that book the author seems to get along quite comfortably without the word.

Selva is a Portuguese word like any other, but it is very little used and has no special application to the forests of the Amazon. The Brazilians do not distinguish the forests of the Amazon by any special word; they are called *mattas,* which is the word applied to any and all heavy forests alike.

J. C. Branner

Rio de Janeiro, Brazil,
June 6, 1913

DOES A LOW-PROTEIN DIET PRODUCE RACIAL INFERIORITY?

To the Editor of Science: In your issue of June 13, 1913, is contained a communication by Dr. Edgar T. Wherry entitled: "Does a Low-protein Diet Produce Racial Inferiority?" The purpose of the article is to dispose of two objections that have been raised against such a dietary, by the application of the results of recent investigations. It seems to me that, in attempting the removal of the first objection, the article is open to some misconception, while, in the case of the second objection, the attempted disposal is far from being effective.

Dr. Wherry is presumably dealing with instances of recognized racial inferiority, and the inclusion of the Japanese people in this category, especially by an advocate of the low-protein theory, is a matter of some surprise. That the Japanese exhibit "some points of physical inferiority, or lack energy, aggressiveness, or courage," when compared with the European, for instance, on a protein-rich dietary, is hardly a generally recognized fact, nor is it in harmony with the contentions of Chittenden and others of his belief that in the Japanese we have an instance of a people "who for generations have apparently lived and thrived on a daily ration noticeably low in its content of proteid. . . ." Chittenden utilizes this fact "as confirmatory evidence, on a large scale, of the perfect safety of lowering the consumption of proteid food to somewhere near the level of the physiological requirements of the body," and believes that "generations of low-proteid feeding, with the temperance and simplicity in dietary methods thereby implied, have certainly not stood in the way of phenomenal development and advancement when the gateway was opened for the ingress of modern ideas from western civilization."[1]

The conceptions regarding the etiology of beri-beri have not undergone any radical change in the last year or two. The information that has been accumulated recently in regard to this disease has served to confirm and extend such conceptions, not to revolutionize them. For years it has been definitely known that the use of polished or husked rice is directly or indirectly involved in the causation of beri-beri. In proof of this statement I only need quote the extensive investigations of Fletcher[2] and of Fraser and Stanton,[3] published six and four years ago, the results of which, obtained from large numbers of individuals, point unequivocally to an intimate relation between the consumption of polished rice and incidence to beri-beri. The comparatively recent discovery by several investigators of a constituent in rice-bran which cures the polyneuritis of beri-beri simply confirms the previous work above mentioned. Furthermore, this discovery does not at all militate against the contention that has often been raised that a diet containing a liberal and varied protein value is an effective preventive against beri-beri.

I doubt whether Dr. Wherry would find many dietitians, on either side of the argument, who consider the relation between the protein intake and the incidence to beri-beri one of the "supposedly most typical illustra-

[1] "Nutrition of Man," pp. 222–223.

[2] William Fletcher, "Rice and Beri-Beri," *Lancet,* June 29, 1907.

[3] H. Fraser and A. T. Stanton, "An Enquiry Concerning the Etiology of Beri-Beri," *Lancet,* February 13, 1909.

tions of the unfavorable results of a deficiency of protein in the dietary."

The statement most open to criticism in the article of Dr. Wherry is that concerning the generally recognized inferiority of the native inhabitants of India. A recent estimate obtained by the Rockefeller Sanitary Commission that 60 to 80 per cent. of these people are infected with the hookworm, is supposed to "explain away" this inferiority, without reference at all to the diet in vogue. By those who are familiar with the elaborate investigations of D. McCay of the dietaries of the Bangalis and other races of India, upon which has been based, rightly or wrongly, one of the most formidable arguments against the well-known views of Chittenden, this statement of Dr. Wherry must have been read with no small degree of interest and curiosity.

In Publication No. 6 of the Rockefeller Sanitary Commission for the Eradication of Hookworm Disease, entitled, "Hookworm Infection in Foreign Countries," the estimate above quoted of the degree of infection in India is given on the authority of various medical men who are undoubtedly well-informed on the matter. However, the American Vice-consul, C. B. Perry, is quoted as saying (1911):

> Nothing is being done by governmental agencies to alleviate or eradicate the disease except the usual sanitary measures for the prevention of fecal contamination of the soil and hospital treatment of incapacitated patients. . . . The conclusion that I have arrived at is that though widely prevalent in India, the disease is not considered of a dangerous nature and no special steps have been deemed necessary as yet to combat it.

An editorial appearing in the *Indian Medical Gazette,* a journal from which the Rockefeller Sanitary Commission obtained much of its information concerning conditions in India, in the issue of May, 1913, is of great interest in this connection. In commenting upon a clinical method recently investigated by Stiles and Altman of this country, for determining the completeness of cure in ankylostomiasis (hookworm disease), the following is said:

> It would be interesting to compare the figures with those of India, but in attempting to do so one is faced at once by the difficulty that the question seems to have been approached in the two countries from entirely different points of view. In America, it is evident from the huge number of worms per case, which is well over 1,000, that those are being treated who are suffering from ill-health as the result of infection, that is to say, that they are real instances of ankylostomiasis. In India, on the contrary, the matter has been chiefly taken up as a routine examination of all prisoners admitted into a jail, and most of such men are healthy. In these cases an infection of 100 worms appears to be quite unusual, and quite naturally an infection of a dozen worms will make no appreciable difference to a man. These slight infections are the rule in India, the percentage infected varies in different parts from about 35 to 75 in men of the laboring classes, and the mild infection seems to have no effect on the health of the host. This general mild infection makes any anti-ankylostoma campaign quite hopeless in this country for many years to come. Severe cases do, of course, occur, but, speaking generally, we hear little of them. Their relative distribution in different parts of India is unknown. Our knowledge of ankylostomes in India is quite meager, in spite of the amount of work which has been done by I. M. S. officers, and much of the work will have to be done over again.

Apparently, hookworm infection, while common in India—at least among the laboring classes—is in the great majority of cases extremely light and can not be supposed to exert any noticeable effect upon health and development. To ascribe the racial inferiority of the inhabitants of India, therefore, to such infection seems entirely unwarranted from the data at hand.

Thus, the question of Dr. Wherry, "Is there any evidence whatever that a low protein diet ever causes or aids in the production of racial inferiority," is in precisely the same status now as it was before his article appeared. In fact, however much one may disagree with the interpretation that McCay puts upon his own data, the unprejudiced must admit that the data are extremely suggestive of a deleterious effect of long-continued adherence to the low-protein dietary. However much one may be-

lieve that the low physical development and efficiency of the native races of India as compared with the Eurasian or the European in the same country and under the same conditions, are due to unsuitable food materials, insufficient diet during the period of growth, or to any other factor than the low-protein intakes of the adult population, the possibility that the latter is a contributory factor at least can not be denied, nor can it even be supposed to be very improbable.

H. H. Mitchell
University of Illinois,
Urbana, Ill.

THE SPIRIT OF AGRICULTURAL EDUCATION

The recent communication to Science for May 9 by Dr. Raymond Pearl, and the discussion thereon in Science of June 13, by Dr. Davenport, causes one to surmise there are at least two opinions in the United States relative to research in experiment stations.

Dr. Pearl apparently deplored the seeming fact that experiment station workers must "supplicate the great Goddess Truth with one ear closely applied to the ground in order that he must catch the first and faintest murmur of 'What the public wants.'" He did not say "the public be damned" and perhaps he did not mean to. He did, however, give at least one reader the impression that he has small faith in farmers as patrons of experiment-station work. He apparently did not council experiment station workers to make an effort to adapt their results to the understanding and needs of "uncritical farmers." He would seem to think that this genus farmer, true to type as he is, had better be taught to look "through a glass darkly."

If agricultural experiment stations were established for any particular purpose toward our civilization, it was and is to serve the needs of farming people. It is a part of their job to adapt themselves and their work to the needs of such people. If they will do that very genuinely and sincerely, they will find these same people appreciative. If in any such instance they do not respond so quickly as they should, the greater is the obligation upon the experiment station and its associated college to help them. Who does the work, anyway, which supports these various experiment stations, from the favored state of Maine to the other ocean?

These paragraphs are not written solely to disagree with so evidently an illustrious worshiper of the "great goddess Truth" with his "ear to the ground." Such would hardly be worth while. But it has virtually been charged in public print, by a reputable member of an experiment station staff, that much work and many workers of experiment stations are insincere. Such a charge, insidious as it is, does most insidious damage—undemocratic as it is in spirit, it would lead logically to the discrediting of our experiment stations as unworthy of support in a democracy.

If there is anything the matter with the land-grant colleges and experiment stations, it is that they have occasionally loaded upon them such pseudo-scientific junk as Dr. Pearl might apparently like to have our "uncritical farmers" unwittingly support. It is a mighty serious matter that if any of our land-grant institutions fail of popular support it will be because they fall victims to pseudo-science.

By pseudo-science I mean that so-called pure scientist who does his work or holds his job (and draws his salary) under the name of agriculture, with contempt in his heart for real farm people. Just such codfish aristocracy has failed visibly to accomplish much for the peasant farmers of Germany. However erudite it may be, it will fail of accomplishing much for American farmer citizens, as such.

Right now the land-grant colleges and experiment stations are on trial to show what real service they are capable of rendering to our farm citizenship. It is within their power to make a most conspicuous success.

If our American agricultural institutions should continue to organize themselves around pseudo-scientific units—*e. g.*, agricultural chemistry, agricultural botany, agricultural economics, agricultural what-not, or any old

thing to give some old-school aristocrat a job of foisting some mighty poor science and poorer agriculture upon farmers, then they will deserve to go down with those they fail to minister unto.

If our American land-grant colleges and experiment stations shall faithfully and fearlessly disregard old, artificial precedents, and organize themselves around agricultural units, it will be they who preserve the intellectuality of our great body of farmer citizenship. Will they do it? is the question to-day in the mind of the "uncritical farmer." This same farmer has time and again since the battle of Lexington shown his willingness to bear the burden of any real and sincere educational need.

And now, if any pure scientist delights not in agriculture, and in the problems of the farm, he should draw his salary from some more congenial source. It is the function of pure science to increase the sum of human knowledge. Let her worshipers be about their high calling.

It is the function of the experiment stations to apply themselves to the solution of the problems of agriculture. Such work this hour demands not only the finest skill and cleverness, but the most searching integrity. Such is real worship of the "great Goddess Truth."

The very insincere practise of trying to deceive their constituency, which Dr. Pearl seems to cite, as the only recourse for doing scientific work in experiment stations, is that which could result in the prostitution of all science, and which might result in the degeneration of American agriculture.

A. N. Hume

South Dakota Experiment Station

THE TARIFF ON BOOKS

To the Editor of Science: As most of us probably think of the new tariff law as one that reduces duties, it may be well to call the attention of readers of Science to one or two items of increase that are of interest.

Books in foreign languages *are no longer* to be on the free list, and books over twenty years old must *also have been bound over twenty years* to be entitled to free entry.

As most German books are bound after publication, and there is no telling when, this might be a serious impediment to easy ordering of books from second-hand catalogues.

As a revenue measure will it yield enough to pay for the delay and obstruction to the *free* circulation of knowledge involved? This is not a bit of the "New Freedom," I trust.

Alfred C. Lane

SCIENTIFIC BOOKS

Catalogue of the Mammals of Western Europe (Europe exclusive of Russia) in the collection of the British Museum. By Gerrit S. Miller. London. Printed by order of the Trustees of the British Museum. Sold by Longmans, Green & Co., 39 Paternoster Row, S. C.; B. Quaritsch, 11 Grafton Street, New Bond Street, W.; Dulau & Co., Ltd., 37 Soho Square, W., and at the British Museum (Natural History), Cromwell Road, S. W. 1912. All rights reserved. 8vo. Pp. 15 + 1019; 213 text figures.

Mr. Miller's "Catalogue of the Mammals of Western Europe" supplies a long-needed authoritative manual of the mammal fauna of Europe. It includes, however, only the land mammals, it excluding the seals and cetaceans. The Gibraltar macaque and the Indian buffalo are omitted as being artificially introduced species. Geographically it is restricted to continental Europe outside the Russian frontier and the immediately adjoining islands, but includes also Spitzbergen, Iceland and the Azores.

The preface, by Dr. Sidney F. Harmer, keeper of zoology at the British Museum, states that a work of this nature "was many years ago suggested by the late Lord Lilford, who kindly contributed an annual sum towards the collecting necessary for its realization," but "the possibility of issuing the present catalogue has mainly grown from the work which its author, Mr. Gerrit S. Miller, of the United States National Museum at Washington, has for some years been doing independently on the subject." Through the

Lilford Fund and contributions by Major G. E. H. Barrett-Hamilton, who has published many papers on European mammals, and by Mr. Oldfield Thomas, curator of mammals at the British Museum, material for the work slowly accumulated, but its preparation was not begun till 1905, when, as Dr. Harmer states, "Mr. Miller arranged to devote his entire time for a considerable period to the study of European mammals. The opportunity was taken of having the results of this work published here instead of in America, by inducing him to write a British Museum Catalogue; thus utilizing his knowledge, and combining for the purposes of his studies the material of both the American and the British National Museums. Collections were then made in various selected areas, partly by Mr. Miller himself and partly by trained collectors . . . the cost of whose services were contributed by friends of the museum." Mr. Harmer adds: "The catalogue could hardly have been contemplated if it had not been for Mr. Thomas's unremitting efforts in developing the collection. He has not merely regarded these efforts as an official duty, but he has in addition been a generous donor who has frequently supplied funds for the purpose of obtaining specimens. Mr. Miller has thus had at his disposal a collection fairly representative of all parts of western Europe, and immensely superior to anything that had been thought of before he began work."

The author, in his introduction, goes into details in respect to the gathering of this material, with reference to its geographical sources, donors and collectors, and the museums, public and private, from which types and other important specimens were borrowed for examination. Altogether the number of specimens on which the work was based, it is stated, "approximates 11,500," of which about 5,000, including 124 types, are in the British Museum, about 4,000 in the United States National Museum, and the rest in various European collections. Nearly every section of the area embraced is represented by collections, more or less extensive and recently gathered, but not always sufficient for the task in hand, for the author states: "This material has been found sufficient, in most of the groups, to give what appears to be a fairly satisfactory idea of the essential features of the fauna. In the ungulates and the larger carnivores, however, it is so totally inadequate that no attempt could be made to revise the genera by which they are represented. This is especially to be regretted on account of the fact that some of these larger mammals are nearly extinct, while others are being modified by the introduction of foreign stock to replenish exhausted game preserves. Immediate action is necessary if the final opportunity to gain a clear understanding of this part of the European fauna is not to be lost."

The number of forms recognized is 314 (195 species[1] and 119 subspecies), referred to 69 genera. All are represented in the British Museum except 22, and all but 6 of those included were examined by the author. All questions of nomenclature have been decided by the rules of the International Code. The citations of the literature are "restricted to those which seem of importance in giving a clear idea of the systematic history of each animal"—to synonymy and original descriptions of the genera, species and subspecies, to the first use of the names adopted, to the "monographic works" of Blasius and Trouessart, and to such other publications as are pertinent to particular cases. Of the 213 text figures, representing skulls and teeth, nearly one half are original, drawn by Mr. A. J. Engel Terzi, of London; the others were loaned by the Smithsonian Institution and were drawn by Mr. H. B. Bradford.

As usual in similar monographs, keys are given for the families, genera and "forms" (species and subspecies). The descriptions of the species are detailed and comprehensive, and include external and cranial measurements. The cranial measurements are tabulated and often occupy a number of pages for a single species. The illustrations are restricted to the skull and teeth of each species, there being three outline views of the skull, all

[1] Only 30 per cent. of the species are represented by subspecies, 70 per cent. being monotypic.

natural size except when the skull is too large for full representation on the page, when it is shown reduced to a stated scale; the teeth of small species are represented in well-executed drawings, enlarged 5 to 10 diameters; those of large species are drawn natural size. Lists of "specimens examined" are given for each form, with their localities, and in addition a catalogue of those belonging to the British Museum.

It is to be regretted that the author found the literature of European mammals "so voluminous, particularly as regards local lists and special notes on distribution," and so difficult to correlate with our present "conceptions of species and local races," that he considered the labor of citing it in "extended bibliographical tables for each form recognized" would be "incommensurate with the importance of the results." The labor would have been undoubtedly very great, and the citations would have considerably increased the size of an already rather bulky volume, but it is work greatly to be desired, and also work that can be properly done only by an author having Mr. Miller's expert knowledge of the subject. The citation of the more important general works and papers relating to European mammals, however, would have been an aid to students desiring information additional to the technical descriptions of the present work.

As an illustration of the author's resources and method of treatment, the genus *Sciurus*, or the arboreal squirrels, may be cited. It may also serve as an illustration of the early slow and recent rapid development of European faunistic mammalogy.

The describing and cataloguing of the mammals of western Europe began long before the labors of Linné, but he was the first to give them modern systematic names. During the last half of the eighteenth century about a dozen different authors had described and named European mammals, so that by the end of that century nearly one half (90 out of 195) of the forms given in the present work as *full species* had been described and named. These comprise all the leading types, those added later being for the most part small or obscure forms, many of which would not have been given recognition in that early day even if they had been known. Of these eighteenth century species, Linné alone named two thirds, and three other authors (Schreber, Pallas, Erxleben) named two thirds of the remainder.

During the first 95 years of the nineteenth century (1800–1894) 56 species and subspecies were added by 34 authors. Up to 1895 the authorities for the names of species and subspecies, on the basis of Miller's nomenclature, number 50; but most of the post-Linnean genera and subgenera were founded by systematists whose names do not often occur as describers of the species and subspecies here referred to them.

In striking contrast with the record from 1758 to 1894 is the record for the next sixteen years (1895–1910), during which period 170 forms were first described, the work of 20 authors, of whom 8 described 133, 66 of which were described by the author of the present "Catalogue," 25 by Barrett-Hamilton, and 10 each by Cabrera and Thomas.[2] A comparison of the two periods—one covering a century and a quarter, the other sixteen years—on the basis of Miller's "Catalogue," shows that 55 per cent. of the now recognized species and subspecies have been described since 1894.

We now return to the illustration afforded by the genus *Sciurus*, represented in the "Catalogue" by a single species, divided into 12 "forms" or subspecies.

(*a*) *Method of Treatment.*—Following a page and a quarter devoted to the "characters" and geographical distribution of the family Sciuridæ, including a key to the European genera, the treatment of *Sciurus* occupies 26 pages (pp. 898–923). A half page, devoted to the synonymy, geographical distribution and characters of the genus, is followed by six pages on the species *Sciurus vulgaris* Linné, including (1) distribution, (2) diagnosis, (3) external characters, (4) color,

[2] Two additional species were described after 1910—one in 1911 and one in 1912. Also many others were described, by various authors, during the 1895–1910 period, which in the present work are relegated to synonymy.

(5) teeth, (6) illustrations (skull and teeth), and (7) key to the European forms. The synonymy is given only under the several subspecies, which are each diagnostically described, with measurements, a statement of its range, the sources and amount of material examined, and a list of the specimens contained in the British Museum. The descriptions of the subspecies occupy 14 pages, an average of a little more than a page to each, while the tables of cranial measurements fill four additional pages and include a total of 103 skulls, with 11 measurements of each skull.

(*b*) *Resources and Results.*—Although three of the here accepted subspecies of *Sciurus vulgaris* date from the eighteenth century, and two others from the early part of the nineteenth, none had become authoritatively recognized as tenable forms prior to 1896,[a] so that of the twelve forms now admitted six have been described and five others established since 1904. All but three of the 12 recognized forms are represented by fair series of specimens (5 to 174), the material examined aggregating 512 specimens. A list of the accepted forms, with their ranges and the number of specimens of each examined, here follows:

1. *Sciurus vulgaris vulgaris* Linné, 1758. Scandinavian Peninsula, except extreme north. Specimens examined, 53.
2. *Sciurus vulgaris varius* Gmelin, 1789. Extreme north of Scandinavian Peninsula, east into Russia. Spec. ex., 8.
3. *Sciurus vulgaris leucurous* Kerr, 1792. British Islands. Spec. ex., 174.
4. *Sciurus vulgaris russus* Miller, 1907. West-central Europe. Spec. ex., 26.
5. *Sciurus vulgaris fuscoater* Altum, 1876. East-central Europe. Spec. ex., 170.
6. *Sciurus vulgaris italicus* Bonaparte, 1838. Italy. Spec. ex., 38.
7. *Sciurus vulgaris lilæus* Miller, 1907. Greece. Spec. ex., 3.
8. *Sciurus vulgaris alpinus* Desmarest, 1822. Pyrenees. Spec. ex., 2.
9. *Sciurus vulgaris numantius* Miller, 1907. North-central Spain. Spec. ex., 22.
10. *Sciurus vulgaris infuscatus* Cabrera. Central Spain. Spec. ex., 5.
11. *Sciurus vulgaris seguræ* Miller, 1907. Southwest Spain. Spec. ex., 11. (Probably same as the next.)
12. *Sciurus vulgaris bæticus* Cabrera. Southern Spain. Spec. ex., 0.

[a] Nearly a dozen others of early date, proposed as "varieties," have never had currency, and are treated by Miller as untenable.

In general method and in details of treatment the "Catalogue" may well serve as a guide and an inspiration in similar undertakings. It furnishes for the first time a solid and orderly foundation for further systematic work on the mammal fauna of the area treated. Although the author's conclusions can not safely be challenged except on the basis of equal or better opportunities for investigation, doubtless some forms have been accepted that further study will show are not well founded, while others probably remain to be discovered. Finally, it is pleasant to contemplate the combination of circumstances that led to the preparation and publication of the work through a combination of the resources of two great national museums, and by an author so eminently fitted for the task.

J. A. Allen

Malaria, Cause and Control. By William B. Herms. New York, The Macmillan Company. 1913. Pp. xi + 163.

The purpose of this little work is to awaken the public interest in the control of malaria through the control of mosquitoes. Its appearance at this time is opportune, as, no doubt due to the example and influence of Celli in Italy, there has been a growing sentiment in many quarters in favor of the control of malaria by the extensive administration of quinine. Quinine control has not only proved impracticable under many circumstances, but under rigorous tests—particularly in the tropics—has even failed altogether. Professor Herms's book is based upon California experience and addresses itself directly to Californians; but in so far as similar conditions obtain elsewhere, it should have a much wider field of usefulness. The treatment is elementary throughout. A large part is devoted to the practical side of mosquito control.

The opening chapter, Economic Considerations, sets forth the direct and indirect losses occasioned by malaria and gives a concrete case to illustrate how serious these may be to a small community. It is shown that in a town of 4,000 inhabitants, in the northern Sacramento Valley, the expense and loss incurred during 1911, leaving out of consideration the resultant depreciation of real estate, amounted to about $75,000. In the itemized account it is shown that this community in combating malaria during 1911 spent $972.50 for quinine and $1,800 for patent medicines. The latter item is particularly striking when one considers that quinine is the only specific for malaria and that such medicines usually contain little or no quinine. They are therefore simply an additional drain upon the malarial victims. The author, basing upon experience elsewhere, states that effective mosquito-control work would cost this community about $2,000 a season and that the result would be the reduction of malaria by at least 50 per cent. the first year and 80 per cent. in the second year. The figures show strikingly how well mosquito-control work pays in a malarious region.

In the chapter, Malaria and its Transmission, the complex life history of the malarial parasites is explained in the simplest possible language, although not altogether satisfactorily. The author seems unaware that the pigment spots of the malarial parasites are the products of the ingested hæmoglobin. The following statement is surely an inversion of cause and effect, both the enlargement of the blood corpuscles and the anæmia being directly brought about by the parasites: "Enlarged parasitized corpuscles occur in this species [*Plasmodium præcox*], but merely as a coincident, since enlarged corpuscles commonly occur in anæmia, and these may be entered by the sporozoits" (p. 21). On page 28 the question is again brought up, and favored, whether there are reservoir hosts other than man for the asexual phases of the parasites. This needlessly obscures the subject, as there is a wealth of evidence to controvert such a belief and it is dismissed by all careful students.

The two chapters Mosquitoes in General and Anopheline or Malaria Mosquitoes show a fragmentary knowledge which the author might easily have remedied by a little careful reading in the works cited in his brief bibliography. On page 31 the statement is made that "the Culicidæ are distinguished from all other Nematoceran Diptera by the presence of scales on the wings and body." Such scales, however, occur in the Psychodidæ and in certain Tipulidæ and Chironomidæ. On page 33 the Culicidæ are said to divide into two subfamilies, the Anophelinæ with the palpi long in both sexes, and the Culicinæ with the palpi long in the male and short in the female. Aside from the fact that the relative length of the palpi is now discarded as a primary character by most students, there exist a considerable number of species with the palpi short in both sexes (Ædinæ of the older authors) and still others which must be looked upon as intermediate. The statement that "the males of all species of mosquitoes, as far as known, are provided with plumose antennæ" is far from correct. The statement (p. 42) that in all "culicine" (as against "anopheline") mosquitoes "except *Stegomyia calopus* the eggs are placed on end, forming a boat-shaped pack or raft," shows that the author is unaware of the considerable progress made within the last ten years in the knowledge of mosquito biology. The statement, too, that single mosquitoes may lay 750 eggs is contrary to the experience of many reliable observers. On the other hand, it is gratifying to find the author contending against the common idea that mosquitoes fly considerable distances. He rightly states that as a rule mosquitoes do not fly far and that the salt-marsh species are an exception in this respect. The chapters which follow deal with mosquito control. The importance of locating actual breeding-places is emphasized. The value of different control measures is discussed, the permanent abolition of breeding-places being held out as the ideal. An insight is given into practical work by a brief account of the local campaigns with which the author has been connected. The book should be useful in

convincing the uninformed that malaria-control through the control of mosquitoes is not only possible, but that it pays. While the inaccuracies do not materially detract from the practical value of the book, it is to be hoped that in the interest of truth they will be corrected in a future edition.

FREDERICK KNAB
BUREAU OF ENTOMOLOGY

SPECIAL ARTICLES

THE ORIENTAL CYCADS IN THE FIELD

CYCADS in the field, cycads in the botanical garden and cycads in the greenhouse, are so different that descriptions based upon plants growing in the garden should be checked by observations in the field, and accounts based upon greenhouse material must be viewed with great suspicion.

In the field, *Cycas circinalis* is said to produce a crown of leaves every year, and under ordinary greenhouse conditions, new crowns are usually produced every year; but where the heat is extreme and the rainfall excessive, two crowns each year may be produced for many years in succession. *Dioon* at Kew surpasses anything I have ever seen at Chavarrillo, but if the Kew specimens should be exposed to the blazing sun of the Mexican tropics, their magnificent crowns would probably wither in a few days. In cycad seedlings at the University of Chicago, scale leaves, which in the field would never have been anything but scale leaves, quite regularly develop into foliage leaves. The cycads, like roses, pinks and chrysanthemums, may appear to better advantage on account of greenhouse conditions, but for phylogenetic studies, their value is doubtful.

During the past year it was my privilege to study in the field the five oriental genera of cycads. Two of these genera are found only in South Africa, two only in Australia, and the remaining genus, *Cycas,* extends from Japan to Australia and Madagascar. Thus all the oriental cycads, except *Cycas,* are confined to the southern hemisphere; while all the western cycads, except *Zamia,* are confined to the northern. No genus is common to the east and the west.

The three genera found in Australia are *Cycas, Bowenia* and *Macrozamia.* All three are abundant in Queensland, the northeast part of Australia, and *Cycas* and *Bowenia* may be confined to this region; *Macrozamia* extends into New South Wales and is represented by at least one species on the western coast.

Cycas, in Australia, is represented by five species, only one of which, *Cycas media,* was studied in the field. The other three were seen in gardens. *Cycas media* was studied at Rockhampton, on the Tropic of Capricorn, and at Freshwater, in the Cairns district, about 700 miles farther north.

Eichler's account, in Engler and Prantl's "Die Natürlichen Pflanzenfamilien," gives *Cycas media* a height of 20 meters, making it the tallest of the cycads. This is undoubtedly a mistake. Dr. F. M. Bailey, in his "Flora of Queensland," states that the species reaches a height of 8 to 10 feet (2.4 to 3.05 meters) and sometimes twice that height. Mr. Simmons, director of the Botanical Garden at Rockhampton, and Mr. Anderson, director of the Botanical Garden at Townsville, assured me that the plant seldom exceeds 3 meters in height and that specimens 6 meters in height were extremely rare. Mr. Sydney Snell, who for many years has lived and hunted in the Berserker Ranges near Rockhampton, showed me the tallest specimen he had seen, and it measured about 6 meters. I received similar reports all the way from the southern to the northern limit of the species. At Freshwater, in the Cairns district, I found one plant which was 7.01 meters in height. The mistake in Eichler's account probably arose in mistaking feet for meters.

A section of the trunk shows the polyxylic condition, but a specimen 2 meters high shows only two or three zones of wood, while a specimen of *Cycas revoluta* half a meter in height might show as many as three or four.

The trunk is ribbed, like that of *Dioon spinulosum,* and the ribs are due to the alternation of foliage leaves and scale leaves or

sporophylls. The ovules have a bright orange color.

The taxonomic descriptions of the four Australian species of *Cycas* are very incomplete, but may be sufficient for identification. All the species grow in the omnipresent but scanty eucalyptus bush, often associated with *Xanthorhiza, Pandanus* and *Macrozamia.*

Material has been secured for a complete morphological study, including the anatomy of the adult plant and the seedling.

The most peculiar of the Australian cycads is *Bowenia,* whose bipinnate leaves readily distinguish it from all other cycads. There are two species, *Bowenia spectabilis,* which is abundant in the northern part of Queensland, about Cooktown, Cairns and Innesfail; and *B. serrulata,* which is at its best in the neighborhood of Rockhampton, about 700 miles south of Cairns. The range of the species could not be determined, but from the reports of directors of botanical gardens, amateur botanists and others, there seems to be a considerable region between the Rockhampton and Cairns districts, where neither species has been found. *Bowenia spectabilis* has only a few leaves, but they have a deep green color and retain their beauty long after they have been cut from the plant. *Bowenia serrulata* has a much greater display of foliage and, in some places, is so abundant that it forms a dense, but easily penetrated underbrush.

The stems of both species are subterranean, so that one of the most striking differences between them might be overlooked. The stem of *B. spectabilis* is elongated and fusiform, while that of *B. serrulata* is nearly spherical. In both, the leaves are borne on branches from the top of the stem.

Macrozamia, with more than a dozen species, is the dominant genus, and it ranges from the northern part of Queensland to the southern limit cycads in New South Wales, and has at least one species in western Australia.

Most of the species have tuberous, subterranean stems. Among these species, *M. spiralis* is probably the most abundant and widely distributed. It is generally believed that species in cycads are rather fixed, but a study of this species and associated species would soon convince one that there is great variation and, perhaps, mutation. Some of the species, like *M. Miquelii,* closely resemble *M. spiralis;* while others, like *M. heteromera,* bear less resemblance; but nevertheless, specimens of these two species could be selected which so closely resemble each other, that some call them both *M. spiralis.*

M. corallipes, M. Fawcetti and *M. Paulo-Guilelmi* rather closely resemble *M. spiralis.* A field study of several species warrants the suggestion that *M. spiralis* is the source from which the rest of the tuberous species have been derived.

There are only three species with tall, cylindrical trunks, and these are so distinct that they are easily recognized at a glance. All three species are found in Queensland—*M. Denisoni,* on Tambourine Mountain near Brisbane, is regarded by Eichler as the most beautiful species of the genus. The ovulate cones are nearly a meter long and reach a weight of 35 kilos. The seeds are so large that they are used as match boxes. *Macrozamia Moorei,* almost on the Tropic of Capricorn, at Springsure, is of more than ordinary interest on account of its close resemblance to the Mesozoic Bennettitales. Unfortunately, the leaves of this species, like those of most cycads, contain a poison which is very disastrous to cattle; consequently, cattlemen are trying to exterminate the plant, and are succeeding so well—or, from another standpoint, so badly—that in a few years it may be impossible to get a specimen for a conservatory. They poison the plant by chopping a notch and injecting arsenic into the pith.

Macrozamia Hopei, in the Cairns district, is the tallest of all cycads. I did not see it, except in cultivation, but Dr. F. M. Bailey told me that the statement in his "Flora of Queensland" that the species reaches a height of 60 feet (about 18 meters) is based upon reliable information.

Material, photographs and notes for an extended study of all the Australian genera and most of the species have already been secured,

and collections to make the life history studies more complete are being forwarded to Sydney, where they are cared for by Professor Maiden. This work will be continued by my friend, Professor A. A. Lawson.

The two African genera, *Stangeria* and *Encephalartos*, are confined to a narrow strip along the southeastern coast, and throughout most of the range the two genera are associated.

Stangeria is quite fern-like in appearance and was described as a species of *Lomaria* before the cones were discovered. There is probably only one species, *S. paradoxa*, although several attempts have been made to make more species. A species maker, unfamiliar with *Stangeria* in the field, could easily be tempted by carefully selected plants, or even by different leaves from the same plant, for leaves vary from entire to serrate, and sometimes the serrations are so deep that the leaf becomes almost bipinnate. We all know what gardeners can do with ferns of the *Nephrolepis* type.

Stangeria is most abundant on the open grass velt, where it grows in dense grass as tall as the plant itself. It also grows in the shade in the bush velt, and here it becomes much taller than in exposed situations. Were it not for the obvious relation between the grass velt and bush velt forms, one might describe them as distinct species.

Stangeria in the field, with one, two or three leaves, and only rarely with five or six, presents a striking contrast to the cultivated plant, with its abundant foliage.

My own collections, supplemented by collections made in Zululand by Professor W. C. Worsdell, and in the Transvaal by Professor W. T. Saxton, and particularly by collections made near Kentani by Miss Sarah van Rooyen, have made the series for morphological study very complete.

Encephalartos, with about a dozen species, is the dominant genus. I was able to study nine species in the field and saw the rest in botanical gardens. The various species may be placed in three fairly definite groups, one with the stems tuberous and subterranean or extending slightly above the surface; and the other two with stout cylindrical trunks.

Encephalartos villosus, the most familiar species in cultivation, is a type of the tuberous group. It grows in the shade, has a wide range, and at various places is associated with species of the other two groups. *E. brachyphyllus* in Zululand is an interesting but little-known member of this tuberous group. Still less is known of *E. cycadifolius*, which I saw in the field only at East London. The ovulate cone is quite characteristic, but is clearly of the *E. villosus* type. *E. Hildebrandtii*, quite familiar in cultivation, does not occur as far south as Zululand, and, consequently, I did not see it in the field, but it certainly belongs to the *E. villosus* group.

E. caffer may be taken as the type of one of the two groups with cylindrical stems. It is abundant at Van Staadens, near Port Elizabeth, where it grows in the sun, on rocky mountain sides. The ovulate cones are the largest ever reported for any gymnosperm, sometimes reaching a weight of 90 pounds (45 kilos).

A nearly related species, *E. Altensteinii*, quite common in cultivation, was studied at various places from Zululand to East London. This species looks so much like *E. caffer* that the labels in botanical gardens are not always convincing, and local botanists assured me that they could always select leaves from *E. Altensteinii*, which taxonomists, at a distance, would identify as *E. caffer*. Some confusion may have crept into the literature through such practical jokes. A young plant of *E. Altensteinii*—and a plant 100 years old might be called young—could hardly be mistaken for *E. caffer;* but an old plant is sure to make trouble, if one is trying to identify it with a manual. A fine specimen of *Encephalartos* in the Botanical Garden at Melbourne, Australia, bore no label, and the director informed me that he had removed the label, placed there about fifty years before by Baron von Müller, who had identified the plant as *E. Altensteinii*, because the specimen did not agree with that description. A couple of young leaves, doubtless due to a wound at the base

of the trunk, showed typical *E. Altensteinii* characters. In Baron von Müller's time the plant probably agreed with the taxonomic description, which was certainly based upon a young plant. No plant of *E. Altensteinii* with a trunk more than three meters high is likely to agree with the taxonomic diagnosis.

The big cones, as in most of the species, have seeds with a brilliant red seed coat.

The remaining section, which might be called the *horridus* section, on account of its forbidding leaves, comprises four species, all confined to the southern part of the cycad range.

Encephalartos Frederici Guilelmi occurs in greatest abundance at Queenstown and Cathcart. It has a majestic trunk and a fine crown of glaucous leaves. The leaflets are pungently pointed but the margins are not spiny, so that it is only by the numerous intergrades between this species and the next that it deserves a place in the *horridus* section. No other cycad has such a densely tomentose bud. The cones, sometimes five or six in number, are lateral and are arranged around a central bud.

Encephalartos Lehmannii is often confused with the preceding species, but has a broader leaflet, which may be entire, or spiny or may have big, coarse teeth like *E. horridus*. The staminate cones, which have a reddish color and are not very hairy, distinguish the species at a glance. The ovulate cones are equally characteristic, being very tomentose in *E. Frederici Guilelmi* and nearly smooth in *E. Lehmannii.*

The type of the section is *E. horridus,* whose jagged leaves, as sharp and rigid as if they had been cut out from sheets of tin, give this plant a clear title to its name. No cycad is more xerophytic and the various aloes, cotyledons and crassulas associated with it would make a fine study for an ecologist.

An almost unknown member of this section, which I saw only at Trapps Valley, in the vicinity of Grahamstown, is *E. latifrons.* It occurs in the open grass velt and the plants are widely separated from one another, half a mile or more apart. The leaflet is jagged, like that of *E. horridus,* but the trunks are stouter and the cones several times larger. The growth is even slower than in *Dioon edule.* Two plants, about one meter in height, on a lawn at Trapps Valley, have been under observation for nearly fifty years, and I was assured that they always bore leaves, sometimes new leaves, but that they were no taller than when first set out.

One object of the trip was to secure material for a complete morphological study of the five oriental genera. Through the generous cooperation of directors of botanical gardens and local botanists, this object was attained in far greater measure than I had dared to hope.

Even a morphologist should know his material in the field, and so I made careful observations and notes on all the species I could find. One result of the field study was not anticipated. From a field study of the Mexican genera, I had begun to regard the species of cycads as rather rigid. Of the four western genera, *Dioon, Ceratozamia* and *Micrŏcycas* are monotypic or nearly so; *Zamia,* with its thirty or more species, would probably show considerable variation if one could study it from Florida to Chili. The *spiralis* section of *Macrozamia* in Australia and the three sections of *Encephalartos* in Africa show that some cycads are still plastic and show variations which may be fluctuating or which may be mutations. Unfortunately, most cycads do not produce cones until they are from twenty to fifty years of age, and, consequently, one could not begin experimental work with much prospect of seeing results.

CHARLES J. CHAMBERLAIN
UNIVERSITY OF CHICAGO

TWENTY-FIRST ANNUAL MEETING OF THE SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION

THE regular annual meeting of the Society for the Promotion of Engineering Education was held in Minneapolis from June 24 to 26 inclusive. The principal sessions were held in the new Engineering Building of the University of Minnesota and in the West Hotel, the latter being a joint session with the American Water Works Association. A comprehensive series of papers was presented by

members and non-members covering many of the important phases of engineering education and allied matters. Several of these took tangible form in committees appointed to carry out the suggestions presented in the papers. For example, a paper by Professor E. V. Huntington, of Harvard University, on "The Units of Force" was partly instrumental in causing the appointment of a Committee on the Teaching of Mechanics to Engineering Students. In another paper Mr. D. M. Wright, of the Henry & Wright Mfg. Co., suggested the appointment of a committee to study and report upon the standardization of technical terms. This suggestion was carried out.

The presidential address of Professor Wm. T. Magruder, of The Ohio State University, was devoted to the qualifications required in a good instructor. He pictured an ideal instructor as one who knows his subject but is also in mental reach of his students; who has the highest reputation for honesty, right living, patience and sound character; who is in practical touch with the subjects he has to teach and who has unbounded enthusiasm for the work of both teacher and engineer.

Other important papers treated of the construction of buildings for technical schools, instruction in highway and in hydraulic engineering, in shop-work and in drawing. The general subject of academic efficiency was discussed by Professor H. S. Person, director of the Amos Tuck School of Dartmouth College. President A. C. Humphreys, of the Stevens Institute of Technology, and Professor G. F. Swain, of Harvard University, championed the four-year as against the courses requiring five years or longer, while the opposition was led by Professor F. H. Constant of the University of Minnesota. The results of the operation of the systematic grading system in use at the University of Missouri were described by Professor A. L. Hyde. Professor F. P. McKibben, of Lehigh University, called attention to the advantages of summer work for engineering students and explained how his students arrange for such work. A very interesting session was devoted to engineering college shop practise and engineering drawing. Professor J. V. Martenis and Mr. W. H. Richards described how shop work is made attractive and stimulating to the students by making the exercises lead to something definite. An extensive exhibit was used to illustrate the working out of the plan. Professor T. E. French, of The Ohio State University, a most successful teacher of engineering drawing, showed how this subject can be taught effectively. Among other papers one by Professors C. E. Sherman and R. K. Schlafly, of The Ohio State University, described a novel practise of sending civil engineering students into commercial work during the summer under the direction of instructors if the students could not obtain regular summer employment. Professor H. Wade Hibbard, of the University of Missouri, presented directions for thesis work and gave a long list of subjects suitable for investigation. Mr. Ivy L. Lee, executive assistant, the Pennsylvania R. R. Co., gave some excellent suggestions from the employers of technical graduates to the teachers, indicating how the latter can exert helpful influences in the right direction. These suggestions were well received and provoked considerable discussion. In addition to the papers there were committee and officers' reports, all of which showed the society to be in good condition and alive to its opportunities.

A number of social functions and excursions increased the pleasures of the meeting and enabled the members to meet the faculty of the University of Minnesota and their families and to appreciate the remarkable beauty of the country around Minneapolis.

The following members were elected to serve for one or more years in the positions indicated: *President*, G. C. Anthony, Tufts College, Mass. *Vice-presidents*, H. S. Jacoby, Ithaca, N. Y., and D. C. Humphreys, Lexington, Va. *Secretary*, H. H. Norris, Ithaca, N. Y. *Treasurer*, W. O. Wiley, New York, N. Y. *Councillors*, H. W. Tyler, Boston, Mass.; J. F. Hayford, Evanston, Ill.; A. S. Langsdorf, St. Louis, Mo.; S. M. Woodward, Iowa City, Iowa; M. S. Ketchum, Boulder, Colo.; F. P. Spalding, Columbia, Mo., and P. F. Walker, Lawrence, Kans.

President Magruder made the following important committee appointments, carrying out the instructions of the society: *Joint Committee on Engineering Education*, G. C. Anthony, A. N. Talbot; *Committee on Teaching Mechanics to Engineering Students*, E. R. Maurer (chairman), L. M. Hoskins, S. M. Woodward, C. E. Fuller, L. A. Martin, Jr., Wm. Kent, S. A. Moss, Albert Kingsbury, H. F. Moore; *Committee on Teaching Physics to Engineering Students*, D. C. Miller (chairman), G. V. Wendell, J. M. Jameson, W. S. Franklin, H. M. Raymond, O. M. Stewart, E. P. Hyde, G. A. Goodenough, F. K. Richtmyer; *Committee on Standardization of Technical Nomenclature*, J. J. Flather (chairman), W. D. Ennis, S. C. Earle, F. N. Raymond, D. M. Wright; *Committee on Statistics*, A. J. Wood (chairman), F. A. Barnes, F. A. Fish, J. D. Phillips, H. H. Stoek.

SCIENCE

FRIDAY, AUGUST 8, 1913

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE INTERPRETATION OF NATURE AND THE TEACHING LABORATORY[1]

There is a universal tendency among mankind to conceive all beings like themselves and to transfer to every object those qualities with which they are familiarly acquainted.—David Hume, 1817.

I

IN all ages human conduct has been largely determined by contemporary opinion, and contemporary opinion by current interpretations of nature. When, for example, the Greeks held that the sun was a god, driving a chariot of fire daily across the sky, it was natural for them to worship and revere the sun as the great giver of light and life. For us moderns, holding, as we do, that the sun is a flaming globe of gas, to do likewise is impossible. Savages, believing that disease is due to demoniacal possession, naturally employ charms for prevention and incantations for cure, while we, holding as we do, that typhoid fever comes only by microbes discharged by antecedent cases of that disease, invoke for prevention disinfection of excreta and protective inoculation, and for cure reinforcement of the vital resistance of the patient. In all cases conduct is determined, consciously or unconsciously, by contemporary interpretations of nature, and we shall find it instructive as well as helpful to review briefly some of those accepted interpretations of the past which for longer or shorter times have occupied the minds of men.

And first we must touch upon those savage and barbarous interpretations character-

[1] An address at Bates College on the dedication of the Carnegie Laboratories of Physics and Biology, January 14, 1913.

istic of the childhood of the race in which everything outside of man is interpreted as essentially manlike in essence, life more or less manlike being assumed to be everywhere—in sea and sky and air and earth—acting in manlike ways and thinking manlike thoughts. This interpretation, the basis of much of our most imaginative speech and poetry, is still fascinating and full of interest.

We need not here raise the world-old questions of realism versus idealism in philosophy. In the childhood of the race, as in the childhood of every one of us today, the visible universe was intensely personal, palpitating with a life closely similar to our own and only gradually separated from it by the slow teachings of experience. For precisely as the child of to-day gazes upon kitten, doll or dog and interprets these as charged with a life and character similar to his own, so in the childhood of the race mankind saw in the wind-swept tree, generally at rest but sometimes swayed as by an unseen hand, a living agency to whose touch the awakened tree responds as if from sleeping or dreaming, now by deep sighs or soft murmurs, now by groaning or roaring. And when Lowell in his "Under the Willows" exclaims, "My Elmwood chimneys seem crooning to me," he is simply making modern poetical use of a fireside music which by his remote ancestors would have been interpreted as spirit voices.

It was doubtless one of the greatest forward steps ever made in the emancipation of the human intellect when Pythagoras of Samos before the Golden Age of Greece detected a constant and impersonal relation between the length of a vibrating string and the sound which accompanied it. This discovery of the monochord still stands as the very foundation of acoustics in spite of the fact that it was immediately misinterpreted by Pythagoras and his followers as signifying a universal relation between sound and music and number, and a universal existence of undetected harmony in seemingly silent bodies, an interpretation which lingers even yet in the phrase "the music of the spheres," and has furnished us with many beautiful lines of poetry, such as those of Shakespeare and Milton, and the following much later, from Pope's "Essay on Man":

> If Nature thundered in his opening ears
> And stunned him with the music of the spheres,
> How would he wish that heaven had left him still
> The whispering zephyr and the purling rill.

Longfellow only yesterday referred to

> The Samian's great Æolian lyre
> Rising through all its seven-fold bars
> From earth unto the fixed stars
> And through the dewy atmosphere
> Not only could I see but hear
> Its wondrous and harmonious strings
> In sweet vibration sphere by sphere.
> —"The Occultation of Orion."

And even in recent times no meaner a philosopher than Karl Ernst von Baer has asked if there is not "perhaps a murmur in universal space, a harmony of the spheres, audible to quite other ears than ours." (Gomperz.)

Yet Pythagoras lived not long before the golden age of Greece and we do not find even among the Greek nature philosophers many less mystical interpretations.

Students of the history of mathematics refer to three famous mathematical problems of antiquity as "the three classical problems," so called because no satisfactory solution of them could be found; but external nature and inductive science had also their "classical" problems, such as the meaning of day and night, the periodic coming and going of the seasons, the rhythmic phases of the moon, the annual rise of the Nile, the winds, the pulsating tides, all sorts of sounds and music, the origin of man and of the lower animals

and plants, the significance of life, death, generation, sleep and dreams. These were all perennial problems and all insoluble. The men of Greece moved as in a maze, not only ignorant, as we are, of man's origin and fate, but, unlike us, dreading the things around them, since most of these, like the lightning and the hurricane, were not only not interpreted but seemingly might come at any moment to kill or to crush.

At first man stands before the roaring loom of Time, gazing in helpless perplexity at the movements of the infinite shuttles, ignorant of the movements which may be beneficent and of those which may be destructive to him. . . . He has to find his friends and his foes amid the multitude of forces which surround him. . . . The spontaneous activity of his growing intellect urges him to make out some scheme by which the various phenomena may be bound together. He begins to link the known and accessible on to the unknown and inaccessible; he animates the universe; interprets all he sees by all he feels.—G. H. Lewes.

This childlike anthropomorphism, however, failed to satisfy the minds of the more cultivated Greeks, who, having nothing else to fall back upon, retreated from it into a kind of agnosticism or into crude forms of atomism such as that of Democritus. Even the great Hippocrates, while pleading for observation and virtually beginning clinical observation as well as holding to the healing power of nature, was so ignorant of anatomy and physiology and pathology as to be able to offer nothing better as a theory of disease than his well-known suggestion of the four humors, of which the sole merit—though at that time a very great merit—was that it focused attention upon the patient rather than on priest or temple or bloody sacrifice; that is to say, on the disease itself rather than on some ancient dogma. Empedocles, it is true, is believed to have used natural means to forestall disease when he cut down the hill behind Girgenti and drained the malarial marshes of Selenunti, the parsley city. Aristotle, too, for the most part seems far away from anthropomorphism in most of his thought and work, but while all the middle age regarded him with Dante as "the master of those who know," Lewes has truly said:

It is difficult to speak of Aristotle without exaggeration; he is felt to be so mighty and is known to be so wrong. . . . His influence has only been exceeded by the great founders of religions; nevertheless, if we now estimate the product of his labors in the discovery of positive truths, it appears insignificant when not erroneous. None of the great germinal discoveries in science was due to him or his disciples.

The Roman period was practically sterile as to any helpful interpretations of nature, the great work of Lucretius being for the most part an amplification of that of Epicurus; while the triumph of christianity and, later, of Mohammedanism over the Roman world, or parts of it, merely imposed upon it oriental interpretations which by substituting few gods or one for the multitudes of Greek mythology, simplified without wholly depersonifying nature. It may well be, however, that the introduction of the Hebrew Scriptures into the western world afforded a real relief from the overhumanized and top-heavy interpretation of the Greeks and Romans. What a cool refreshment follows, for example, a verse like this taken from those Scriptures: "The wind bloweth where it listeth; thou hearest the sound thereof, but canst not tell whence it cometh or whither it goeth." Here is no excessive anthropomorphism. The wind and its blowing do not strike us as interpreted differently from our explanations of to-day. Sound is personified, but at the same time we have a frank admission of ignorance as to its origin and fate. As opposed to the theory of Æolian origin and the assumption of personality we have

cool, calm abstraction which may well have been grateful even to Greeks weary of a refined anthropomorphism.

All through the dark and the middle ages interpretations of nature more or less anthropomorphic and childlike remained common. Shakespeare is deeply tinged with them, while Francis Bacon, catching cold and dying from his famous experiment on the cold storage of poultry, stands out as even more original for this than as the author of the "Novum Organum." It is the glory of the Renaissance that it began the age of experiment. Hippocrates had displayed something of the modern spirit, but he was born too soon. Roger Bacon had it in fuller measure and paved the way for Gutenberg and Copernicus and Leonardo da Vinci and Columbus and Gilbert and Magellan. In the sixteenth and seventeenth centuries for the first time in history a succession of ardent students investigated, and in our modern fashion interpreted, the external world.

Thenceforward events moved rapidly. Galileo and Kepler were followed by Harvey and Boyle and Newton; the telescope, the thermometer, the barometer and the compound microscope came into being; scientific societies sprang up and the modern order began. Old interpretations gradually passed away. All things gradually became new. Matter and energy in myriad forms and combinations replaced the gods of old, with the result that since the time of Newton man has looked out upon the world about him, without fear and as if upon the face of a friend.

II

Teaching must forever recapitulate and epitomize the achievements of the race. Consciously or unconsciously it acts along the lines of the biogenetic law. Beginning with the child who thinks as a child, it offers to him fairy tales in which nature is personified and encourages (note the word) him to see in things about him a life akin to his own. Then comes the awakening, when Santa Claus becomes a benevolent myth and dolls are discovered to be stuffed with sawdust. Next follows the slow recognition of earth and sky, of sun, moon and stars as inanimate objects, and finally the discovery of law and order in the universe.

To facilitate and abbreviate this process and to ensure a sound result, teachers of natural philosophy in the old days performed experiments before their classes. Then came the teaching laboratory, not so much as a workshop as a place for demonstration, experiment and research. The real workshop or laboring place is oftenest none of these, but simply a space in which routine operations of one or various kinds are done over and over again for profit, as, for example, in a shoeshop, a box factory or a cotton mill. The college laboratory of physics and biology is not, and never should be, this sort of workshop. It is rather a place where such demonstrations of principles or processes are made as shall serve for education rather than commerce. A place where old and perhaps famous experiments, chosen for their educational value, can be performed with and by successive classes, and where investigations that promise to yield new or improved results can be prosecuted under favorable conditions. It supplies the room, the apparatus, the power, the raw materials and especially expert and wise guidance, by means of which a personal knowledge of nature can be gained in orderly fashion, and a fundamental and lasting training effectively acquired. It is an indispensable tool or instrument with which to gain rapid and intimate personal acquaintance with nature and the laws of nature. It should

afford for the student a kind of moving picture of the progress and the conquests of science. With the vast extension of the field of knowledge during the last three hundred years it has become impossible for any one to grasp the enormous quantity of facts at our disposal. And yet the child, instead of beginning where his father left off, must begin exactly where his father did. Hence the urgent need of careful choice of facts, choice of experiments, of apparatus and of educational machinery if he is to go in one short life even a little further than his father went. In short, the modern college laboratory is not so much a workshop as a school room, in which selected natural phenomena, facts and processes may be conveniently, rapidly and successively demonstrated and enforced. It should provide at the outset an epitomized, easy and rapid recapitulation of the slow and laborious discoveries of the past, and thus somewhat resemble the museum of art or natural history which likewise affords examples or models of past achievement. That it is essentially dynamical while the museum is statical alters nothing of its recapitulative educational function; that it must necessarily compress the long history of the past into a short time, so that it shall give only an epitome of human progress, is inevitable, and if well done is not merely unobjectionable but desirable.

We hear much nowadays of economy and efficiency in education, as elsewhere, but we have yet to learn that true efficiency in education is not to be measured so much by the number of hours devoted by the teacher to his pupils or to his laboratory or by the time spent by scholars upon their tasks as by the wisdom of his decisions what to teach, and in what order, and especially what to omit. It is easy, though never wise, to seek to cover the whole field, but it is not easy to discover which phenomena, which experiments, which demonstrations are most worth while, most productive of genuine learning, of good judgment, common sense, real wisdom and power.

But whatever our endeavor, this must always be—consciously or unconsciously—an attempt to lead the student on to a sound and true interpretation of nature. And surely the modern interpretation, as we seek and find it in laboratories like this one which we dedicate to-day, is objective rather than subjective. It begins with the rigorous abnegation of ourselves, and a calm survey of the world about us, charged with impersonal matter. The lightning plays about us with the same energy as in Homeric days, but it is no longer Zeus who sends it forth. The waves fling themselves upon our rocky shores to-day precisely as of old they beat upon the islands of the Ægean, but we do not see in them, as did the Greeks, the fury of Poseidon. We see only an almost irresistible pressure of the atmosphere in motion. For us the winds are not the messengers of Æolus, but only lifeless gases caught up and dragged by the swiftly spinning earth or seeking an equilibrium upset by local expansions or contractions due to heat or cold.

Is there, we may well inquire, any more important function for modern scientific education than to interpret, in a laboratory like this which is dedicated to-day, to earnest and eager youths such as the state of Maine sends to her colleges, that nature of which man himself is at once the crowning glory and the principal problem! To inform, to instruct, to adjust—if possible even to attune—the thought, the opinion of youth; to correlate its activities to its environment so that its internal relations may become usefully, efficiently and

happily adjusted to those external relations which were never more complex or more exacting than to-day,—this is our problem. We hear at present much of wars and rumors of wars, and a new social heaven—or at least a new earth that is to become a new heaven. But the universe moves on in its appointed ways. The sun and the moon and the stars and the seasons and day and night are with us, as of old. Plants and animals only slowly change their nature, and mankind is born and lives and dies much as it has always done. Art, to be sure, has become vastly longer, but life is still nearly as short as ever and relatively to the things to be seen, to be learned and to be done, infinitely shorter. The fundamental problem of all education, namely, preparation for life, is therefore no less, but rather infinitely more, important.

But with the aid of laboratories like this, generously furnished by lovers of their kind, in which wise teachers, themselves models of devotion to truth and scholarly living and endeavor, by means of examples, epitomes and recapitulations of the great experiments and discoveries of the past, shall enable their pupils to appropriate forever to themselves and to the service of man the accumulating wisdom of the ages, we may go forward with a cheerful courage. Nor does it seem too much to believe that an interpretation of nature which has robbed it of most of the terrors which it possessed for primitive man and has made it increasingly serviceable to the race, will long endure.

W. T. Sedgwick
Massachusetts Institute of Technology

THE FITNESS OF ORGANISMS FROM AN EMBRYOLOGIST'S VIEWPOINT[1]

I am glad to accept an invitation to address this club, for I believe that it is an excellent custom, indeed, almost necessary in these days of specialization, for a biologist to look at his problems now and then from others' points of view and to be brought into contact with men working on quite different aspects of life than his own. The same fundamental problems face all workers in the biological field, be they ecologists, structure-workers, process-workers, breeders, or, I might add, workers in the broad field of the medical sciences, for I believe that the clinician fully appreciates that the problems of health and disease are, on one aspect at least, problems of life and that medicine on its science side belongs in the broad field of biology. It is the unitary character of life and life phenomena that binds us all together and creates bonds of common interest and the goal toward which we all must strive, whether we know it or not—if the minor problems which we attack are correctly solved—is the explanation of life.

It is a goal which perhaps we may never reach or whose outline at some future time will be made out in but crude and hazy form, and yet it does us good ever and anon to pause in our detailed work of analysis and technique and turn our eyes in the direction we believe it lies and to ponder on the road before; it helps us I believe toward a clearer appreciation of the setting of the petty problems that immediately confront us. Perspective is too apt to be lost in the close scrutiny of high specialization. In such a contemplation from afar of the end-problem of the biologist, some, overwhelmed by what lies between, believe it unattainable; and others proclaim that the solution is close at hand; one sees in the intricacies of life evidences of a vital force while for his fellow-worker the explanation is to be wrought out in terms of physics and chemistry alone. For each the attitude of mind that will color his speculations will be compounded out of his personal make-up, the daily routine of his work and the time and concentration that he has devoted to it. The field naturalist easily inclines toward vitalism; the biochemist, perhaps, is biased toward a physicochemical interpretation; the structure-worker —and in this group I would place myself—in

[1] Talk before the Agassiz Club of Cornell University, February 24, 1913.

more or less intimate contact with both fields, may be drawn toward the one or the other camp.

In the interpretation of life phenomena, we can not, of course, escape from the domain of physics and chemistry; the living body is material, and the fundamental physical laws of the conservation of matter and energy hold there as in the inanimate world. In the transformations that take place in organisms, there is no evidence whatsoever known to me of or the least indication that new matter has appeared or new energy been created. We are constrained therefore, if we must postulate a vital force, to conclude that it is a new form of energy developed out of the other energy forms and transformable into them again. Since we know nothing about such a special life form of energy, but only the energy of inanimate matter, there has always seemed to me no value in its assumption, since the analysis must always proceed from the known to the unknown and be expressed in terms of the physics and chemistry of the organism. If in course of time it becomes apparent that another energy form exists in living organisms, it will then be time enough to discuss it; for the present I do not believe it helps to introduce it.

In all analysis of life phenomena, very fundamental it seems to me is the analysis of *life conditions*, those absolutely essential for its manifestation, and you will, I know, pardon my introducing here so elementary a matter as their enumeration. They are: (1) Food-stuffs, *i. e.*, the necessary chemical conditions; (2) oxygen; (3) water; (4) heat, *i. e.*, the adequate temperature; (5) pressure. Out of these, together with a few more that rest upon them as a basis—(6) protection, of diversified forms; (7) elimination of useless material; (8) formation of new individuals as centers of organic transformation—are compounded the fundamental life activities, of the higher organisms at least. It is hardly necessary to insist upon the broad application of the above thesis. Following through the sum total of the activities of an organism—and I would include its structure as but the partial expression of these same activities—untangling in your analysis the complex that they form you come back to the fundamental categories of life manifestation enumerated above and the conditions that underlie them. There is, of course, nothing fundamentally different in the manifestation of life under the given necessary conditions and a chemical or physical reaction. To take a simple example, the rusting of iron. Given the necessary conditions, namely, the presence of water, oxygen, some acid, I am told, such as carbonic acid, and of course iron, under an adequate temperature, and the reaction will proceed at a given rate. Under somewhat different and more complex conditions, the presence of some other acid or salt, and with less pure iron, the reaction will proceed more rapidly. But I am venturing on rather dangerous ground and must withdraw.

There are two aspects of life manifestation which I desire to mention and which will introduce the subject that I chose to discuss with you. The first of these is the continuity of life and all that it includes—growth and reproduction. This in itself would possibly be regarded as more intimately characteristic of life, but I believe that if we were to stop to analyze it out, we would find nothing distinctive in mere continuity. One might, I think, find illustrations of purely physico-chemical reactions taking place in the earth's crust to-day that have been proceeding since its foundations. It is that in organisms *insuring* the continuity which is peculiarly biological. The molding of the life activities of organisms to a more or less specific environment supplying the necessary life conditions so that environment and organism constitute an interrelated system of more or less complexity, is the second aspect I made reference to, and adaptation[2] appeals to me as a second very fundamental fact in biology. Of the truth of this and the great diversity of patterns in which life activities and environment are interwoven in different organisms, you doubtless know better than I who have largely only

[2] The term is employed in the broad sense, and as a passive instead of active noun.

second-hand knowledge of ecological relations. The constancy as well as the complexity of each pattern is the striking thing.

I trust you see with me that there is nothing in the mere element of *fitness* that is peculiar to life. Any chemical reaction requires a fitness of conditons, if we choose to use the word. It is the *pattern* that embodies elements more peculiarly biological. The pattern in the world of living things at the present day is complex indeed, but particularly so in the higher animals, in whose evolution there has been established a complexity of pattern in which the woof colors of organism more and more dominate the warp of outside environment, or, to abandon the metaphor, in the thought of Professor Matthews at the recent symposium on Adaptation, the highest step in the perfection of adaptation has been reached by making the organism superior to, adapted to, all environments; or, differently put, in the taking the immediate life condition environment within the organism itself.

And now we come to the critical point in our attitude toward adaptation. In the use of such terms as fitness, adaptation, control of environment, we invoke teleology. The objection has been raised, and I believe rightly, that to an analysis in terms of cause and effect any consideration of use, purpose, or aim must be extraneous. We should in all instances differentiate between the explanation of the phenomena and whatever teleological significance may attach thereto. The analysis may perhaps not necessarily be directly in terms of matter and energy, but it can take no cognizance of a teleology as a link in the chain. I should like to discuss this aspect of the adaptation problem at some length, but time is inadequate. Here, however, we stand at the branching of the road, we have a choice before us. (1) Either there must be found some substitute for the term adaptation that will avoid the teleological element, or (2) accept a pervading life force in all organisms, animal or plant, whose highest development appears in human consciousness and intelligence, a mind force coextensive with the matter and energy of organized matter. Some day we may be compelled to postulate a directive principle such as the entelechy of Driesch, but I do not believe its assumption at the present stage of knowledge and analysis is necessary or helpful. Personally I believe that the right road leads toward an ultimate analysis and recasting of what we mean by adaptation. The recasting, however, must needs strike deep: ideas of cooperation of organs with specific functions, expressing a division of labor, belong in the same category. The unitary character of the entire life processes and the structure as but the material expression of these is it seems to me the keynote that must be struck and emphasized in all our analyses of life phenomena on the side of explanation in the terms of cause and effect.

And yet I think that the belief prevailing in some quarters that all in life may be explained in terms of physics and chemistry errs equally on the other side. Life in an organism to-day is like a tapestry in which the threads of warp and woof are woven into a pattern of exceeding intricacy and delicacy whose weaving has been going on since the beginnings of life. You may analyze the threads of process as they run in and out to-day in terms of chemistry and physics, it may be, but the pattern stands as a history of the past and the weaving is still largely a secret of the ages. The pattern is the problem of evolution, and inheritance if you will. For me, the pattern in which the life activities of any organism are expressed is threefold, expressed by the words adaptation, form, consciousness. No one of these can I conceive as being explainable in physico-chemical terms. Granting that some day you may know the full chemistry (or physics) of the formation of secretin and how it causes the secretion of the pancreatic juice, there will still remain unexplained the adaptation. Full knowledge of the gross and fine anatomy of the face, the morphogenesis and histogenesis of its development and analysis of the physico-chemical processes underlying these, would, it seems to me, leave still unexplained the cast of feature. Even if we assume that future workers will be able to un-

ravel the complex histological tangle of the cerebrum and analyze the physico-chemical processes that take place therein when it is active, consciousness will remain incomprehensible on such a basis. I have been told of a man who was working on the physical-chemistry of instinct. I feel sure our psychological friends would reject with laughter such a thesis; they might perhaps accept it if it were worded as the physico-chemical processes under lying instinct. You can not analyze the pattern by analyzing the component threads, although that might help you in the end toward fully understanding the pattern. I do not believe you can analyze the pattern of the life activities in an organism, including of course its "behavior," by analyzing the threads of process that compose it. Try it, and I prophesy that failure will result, or you will resort to the assumption of an autonomous vital principle, as Driesch has done. You can not analyze phenomena of one category in terms of those of another. It is possible of course that in time we shall know so much of the activity pattern of organisms and how it was evolved that we shall be able to solve the problem of life, but I do not believe the explanation is so close at hand as some would have us believe, and perhaps we shall never know from inability to unravel the past.

You may gather from what I have just said that so far from regarding those of you working along ecological lines, as I know some of you are, as straying from the road that leads toward the explanation of life, I would consider you as pursuing lines of work in a field peculiarly biological for which I know of no broader and better term than that proposed by Minot—bionomics. My only comment is that such work should be analytical and not merely descriptive, and you can not neglect the texture of the fabric in tracing the pattern.

I have now, I fear, gone far afield in laying before you my attitude toward adaptation and have little time in which to present one or two aspects of the subject that are of interest to the embryological worker and to you as members of a peculiarly bionomic club, if you will let me use the term. If in the following I speak of adaptation, fitness, function, purpose, I shall do so for simplicity's sake to avoid complicated paraphrases, using them as pattern terms solely. As one who is particularly interested in the analysis of structure, I can not but feel the all-pervading element of fitness—adaptation—in structure, and the importance of having a clear conception of what it stands for when interpreting structure. Whatever portion of the organism you select for critical examination offers illustration many-fold, so that I have been puzzled that the existence (not interpretation) of adaptation can be questioned. There are, however, structures in the vertebrate body, as you doubtless know, in which adaptation does not stand revealed; I refer to vestigial structures which, however, stand for adaptations, not present but past, and may be divided into two somewhat distinct groups, of which I will venture to present one or two illustrations. Again I will recall familiar facts to you, from a rather different point of view, perhaps.

The past history of organisms is reflected, however imperfectly, in their development. Past adaptation patterns, no longer applicable, continue over. They may, or may not, play a part in meeting the life condition complex with which that organism is interwoven. The quality of fitness in them may exist or appear to be quite lacking. Numerous illustrations may be chosen from the embryology of vertebrates which are thoroughly familiar to you. The development of the branchial chamber, expressing a fundamental adaptation pattern in the lower vertebrates, subserves no such useful purpose in the higher forms. In connection with it come certain intensely interesting structures in which adaptation may or may not be revealed. I can not appreciate the functional importance of the thymus coming from the third branchial pouch, nor of the similar structure occasionally developing from the branchial chamber farther back. To me the tonsils have no deep hidden part to play in the bodily economy but, useless and in some cases detrimental, stand for a tiny portion of an adaptation that is past. No specific functions have been revealed; but in saying this,

do not understand me to say that these structures are not without a possible effect in the organism. The mesonephros of mammals likewise represents an important adaptation of the past, but Felix has once and again pointed out that evidence of an excretory function is lacking. But these illustrations will suffice. As a record of the past history of the race, they stand as a testimony to the very change in adaptation that the organism has undergone with the progress of time and evolution. As such they afford valuable clues and are thus of taxonomic value.

In the second group I include those adaptations that exist or appear in the course of development to meet the life conditions peculiar to that period. These structures introduce complexities in development. They are present at one period of the life cycle and pass away with changed conditions. Where traces of them remain, they are like the vestigial structures of the first group, a record of past adaptations, but in the individual history and not primarily that of the race. As an example, the Kiemenreste (gill-remnants) of frogs and toads stand as a record of the early adaptations of the frog in its larval period. No function can be assigned them; they appear to have no past history in the race. Again let me repeat I do not say that they may not be without effect in the organism. The most noteworthy instances in this group of structures of interest to the vertebrate embryologist are the fetal membranes, structures developed out of the animal's body (essentially) mainly for the protection, nutrition and respiration of the individual during the early period of its ontogeny and subsequently discarded when no longer needed. Since they are outside the body, they are not continued as vestigial structures; only insignificant folds and so-called ligaments remain as more or less useless remnants.

Such transient adaptations in the individual life history have, of course, been evolved and perfected in the evolution and share with those of the first group a taxonomic value, but with this difference: such adaptations to meet very specific needs at a specific period in the individual's life should, I believe, be used with caution. Let me give the two examples that have impressed me most.

In the development of the fetal membranes of mammals a very marked variation in the arrangement in the different forms occurs. In general the plan of development and relations appears to be broadly characteristic of the different orders. In perhaps the majority the amniotic cavity is formed by folding essentially as in the reptiles and birds. In certain of the rodents, chiroptera, insectivora, and probably primates, however, the amniotic cavity appears precociously in the midst of the ectoderm or trophoblast and only subsequently do the typical structure and relations of the amnion become established. An eminent embryologist of Europe, Hubrecht, to whom are due many of the facts of the early development in these forms, concluded that this method of formation of the amniotic cavity, by dehiscence, is the primitive type and therefore decides in favor of an origin of the mammals from amphibian-like forms. This method of amnion formation appears, however, closely correlated with the method of implantation of the ovum and placenta formation, and inasmuch as the type of placentation represented is obviously the highest and most direct the primitive character of amnion formation by dehiscence may be seriously questioned. The uselessness of such a character for taxonomic purposes is further illustrated by the fact that in but one of the four groups where it occurs is it apparently constant, but amnion formation by folding is found as well in certain of the forms.

My second illustration of the questionable character of such ontogenetic adaptations as clues to genetic relations is the tadpole stage of frogs and toads. The structural relations of the larval organism depart in detail so widely from the typical relations and are so obviously correlated with the immediate life conditions that one is justified, I believe, with Spemann and Versluys in regarding the adult as probably standing nearer the "ancestral line." Founding broad genetic conclusions from the conditions in the tadpole may be done only with caution and reserve. The per-

version of fundamental relations in the larva is well illustrated in the development of the middle ear and sound-transmitting apparatus where my personal interest has centered.

Thus the embryologist in attempting to explain development encounters illustrations of the formation of apparently non-adaptative structures and structures whose adaptative value has apparently been lost. The idea of adaptation must be ever present with him and yet he must avoid the assumption of a "function" for all things, or seek "fitness" as the key to the interpretation of structure. The field or work for him is first of all the analysis of the underlying developmental processes in which adaptation is portrayed. There are, however, always the two aspects, pattern and texture, in life activities.

Illustrations of apparently non-adaptative structures which apparently never are or were adaptative will doubtless occur to you, many of them correlated with sex; others apparently useless and seemingly a pure exuberance of growth and behavior. These I can not discuss; they lie outside my field. They emphasize again that the secret for them as for adaptation lies wrapped up in the complexity of life processes with the obscure and prolonged evolutionary history involved, and our only hope lies in analysis.

B. F. Kingsbury

THE FINAL EXAMINATION OF SENIORS IN AMERICAN COLLEGES

Whether seniors at the end of their college course should be required to take examinations at the same time as other students, or several days or weeks earlier, or whether they should be excused from examinations altogether upon the basis of their term standing, is a problem which is not infrequently up for discussion. While one may hardly hope to settle the matter absolutely, to know the practise in different institutions throughout the country may not be without value.

Early in May, 1912, I sent out a postal questionnaire to all the institutions listed under the head of "Universities, colleges and technological schools for men and for both sexes" in the Report of the Commissioner of Education for 1909, which was the latest volume accessible to me at that time. There were but two questions asked, viz., "Do the seniors in the collegiate department of your institution take their final examinations in the spring term, or second semester, at the same time as, or two or three weeks earlier than, the rest of the students?" "Are some of the seniors excused from the final examination upon the basis of their high average, 85 per cent., 90 per cent., 95 per cent., during the spring term, or second semester?" Of the 493 institutions to which postals were sent, 347 replied, and those replies throw at least some light upon the problem.

The simplest method of dealing with this material is to take the undifferentiated list of institutions in its entirety. Of the total number, 493, 70 per cent., were heard from. Of these, 167 require the seniors to take their final examinations at the same time that the rest of the students do, while 154 set the senior examinations at an earlier date. There were, also, 26 replies which were not definite. This majority of 13, while not great, becomes more significant when one considers the variety which prevails among the other institutions. The date for these earlier examinations varies from two or three days before the regular examinations to seven or eight weeks. The tendency, however, is to have them scheduled one or two weeks earlier, as is shown by 68 and 46 postals, respectively.

The following tables are in the main self-explanatory.

TABLE I

Institutions at which Final Examinations for Seniors are Scheduled Earlier than for Underclassmen

Two or three days earlier	3	Two or three weeks earlier	19
Five days earlier	1	Three weeks earlier	8
Ten days earlier	3	Three or four weeks earlier	1
One week earlier	68	Four weeks earlier	1
One or two weeks earlier	2	Seven or eight weeks earlier	1
Two weeks earlier	46	Scattering[1]	1
Total	123	Total	31

[1] This term designates a card which indicated that some of the examinations are earlier, but did not specify definitely.

TABLE II

Distribution of the Institutions of Table I. according to the Census Divisions

North Atlantic	31	South Central	13
South Atlantic	28	Western	13
North Central	69		
		Total	154

TABLE III

Distribution of all the Institutions to which the Questionnaire was sent

North Atlantic	91	South Central	77
South Atlantic	82	Western	46
North Central	197		
		Total	493

TABLE IV

Number of Institutions Heard from in each Division

North Atlantic	72	South Central	38
South Atlantic	51	Western	35
North Central	151		
		Total	347[3]

TABLE V

The Percentage of Institutions Heard from in each Division

North Atlantic	79%	South Central	49%
South Atlantic	62%	Western	76%
North Central	76%		

TABLE VI

Distribution of the Institutions that require Senior Finals at the Same Time as for Other Students

North Atlantic	38	South Central	22
South Atlantic	21	Western	18
North Central	68		
		Total	167

If we compare Tables II. and VI., it is evident that the two methods of arranging senior finals run rather evenly. The low percentage of returns from the South Atlantic and South Central divisions, as shown in Table V., makes any inference decidedly hazardous. That the ratio in the other divisions would remain about the same, were all the remaining institutions heard from, is likely because of the high percentage of replies obtained from those sections. This part of the problem, then, remains rather indeterminate, when the undifferentiated list of institutions is treated in this simple way.

If we turn, now, to the second problem, viz., excusing from examinations, we find that the alignment of the different institutions does not remain the same. About one half of those that schedule the senior finals early also excuse from the finals altogether provided the term work is satisfactory, and somewhat less than a third of the other group follows the same practise. The percentage accepted as satisfactory ranges from 65 per cent. in one case to 95 per cent. in several others. The majority of the institutions which approve this practise make either 85 per cent. or 90 per cent. the sufficient grade. In Table VII. the distribution of these institutions is given.

Table VII. shows that 121 institutions, or slightly more than one third of all that were heard from, are accustomed to excuse seniors from final examinations in the last term or semester upon the basis of their term or semester standing, or altogether as is true in a few cases. Since 70 per cent. of all the institutions in the country responded to the questionnaire, it is likely that the same ratio would be maintained if all reported. It is also very evident from this table that there is a greater tendency to excuse from examinations among the institutions of the North Central section than elsewhere, since about one half of all the institutions of that sort in the country that replied are located in that section, while only 39 per cent. of all the institutions of the country are in that division. Still further, since 76 per cent. of all the institutions of the North Central division responded to the inquiry, it is likely that this high average prevails among the other institutions of this locality that were not heard from. This is a more definite result than that obtained with reference to the first question by the application of this simple method to the data in hand.

Another method of dealing with the data confirms the result just stated, and yields

[3] This number, 347, represents all the postals returned. Twenty-six of them were too indefinite for use on this first problem. Most of them, however, are usable on the second problem.

TABLE VII

Distribution of Institutions that Excuse Seniors from Final Examinations

	North Atlantic						South Atlantic						North Central					
	Less than 85%	85%	90%	More than 90%	Various[4]	Totals	Less than 85%	85%	90%	More than 90%	Various	Totals	Less than 85%	85%	90%	More than 90%	Various	Totals
Institutions which otherwise require finals at SAME TIME		3	3		3	9			1			1	2	9	9		7	27
Institutions which otherwise require finals ONE WEEK EARLIER		4			5	9	1		2	2	2	7			1	1	4	6
Institutions which otherwise require finals TWO WEEKS EARLIER					1	1		1			2	3	1	2	3	1	4	11
Scattering[3]					1	1	1	1	1		2	5	1	5	5		6	17
Totals		7	3		10	20	2	2	4	2	6	16	4	16	18	2	21	61

	South Central						Western						Totals of all Divisions
	Less than 85%	85%	90%	More than 90%	Various	Totals	Less than 85%	85%	90%	More than 90%	Various	Totals	
Institutions which otherwise require finals at SAME TIME		2	1	1		4		1	2	1	1	5	46
Institutions which otherwise require finals ONE WEEK EARLIER					1	1	1			1		2	25
Institutions which otherwise require finals TWO WEEKS EARLIER			2			2			1		1	2	19
Scattering[3]		1	2		1	4		1			3	4	31
Totals		3	5	1	2	11	1	2	3	2	5	13	121

rather definite information in connection with the practise of setting senior finals at an early date.

The list of institutions given in the "Report of the Commissioner of Education"[5] is complex. If we analyze it and put the state universities in a group by themselves, state colleges by themselves, colleges and universities on private foundations by themselves, and so on, and then get at the annual income of each institution and make corresponding subgroups, much more information is elicited.

It is, of course, not easy to arrange these institutions in income groups. For this purpose, I used the Report of the Commissioner of Education for 1909 and for 1910.[6] A very elaborate treatment would require a study of each institution through the last ten or twenty years. Even then there would be difficulty in determining what group an institution should be placed in because of the fluctuations of income due to growth or decay, increase or decrease in tuition, and the varying amounts yielded by invested funds. The two reports just referred to, however, seem to furnish sufficient material for the purposes of this investigation.

In determining the group to which an institution belongs, I considered the annual income as made up of "tuition and other fees for educational services," the amount obtained from "productive funds," and the amount gained for "current expenses" from "city, state or national government, or private benefactions." It is true that this represents only

[3] This term is used to designate those institutions which schedule senior examinations at other dates than just one or two weeks, as indicated on Table I.

[4] The term "Various" is used to include excusing from examinations at the option of the professor, with or without a definite percentage, and a number of other ways which hardly needed to be presented in detail, while the total of this and 90 per cent. are the preferred satisfactory grades.

[5] Report for 1909, pp. 900–924.

[6] Report for 1909, pp. 961–977. Report for 1910, pp. 943–961.

rough work, and yet when the same test is applied to each institution for two successive years the results can not be far wrong. Table VIII. gives these results in simple form for those institutions which replied to the questionnaire, arranged according to their attitude to the first question, and the institutions not heard from in a column by themselves. The institutions with no incomes listed in these two reports are of course not entered. This accounts for the discrepancy between the total 461 and the 493 to which postals were sent. These income groups, too, I worked out especially in connection with the colleges and universities upon private foundations, since it is with these that the problem seems to be most acute.

TABLE VIII

Educational Institutions according to Groups

		Examinations Scheduled for Seniors				
		At Same Time as for Other Students	Earlier than for Other Students	Scattering	Institutions Not Heard From	Totals
Schools of technology		4	5	1	5	15
Agricultural schools		1	11	1	10	23
State universities		17	13	3	8	41
State colleges		2	2		1	5
State schools of mines					4	4
Military and naval institutions		2			4	6
Universities and colleges on private foundations with an annual income of	$100,000 or more	32	14	2	2	50
	$ 50,000 to $100,000	19	17	3	6	45
	$ 25,000 to $ 50,000	17	32	5	25	79
	$ 5,000 to $ 25,000	65	50	10	59	184
	Less than $5,000	2	1		6	9
Totals		161	145	25	130	461

From this table it is evident that a majority of the state universities and of the colleges and universities on private foundations with an annual income of $100,000 or more, follow the practise of requiring the seniors to take their final examinations at the same time as the rest of the students. Still further, of all the state universities, only four have an income apparently under $100,000 a year. One of these belongs among those with senior examinations at the same time as for other students, two among those favoring an earlier date, and one among those not heard from. Combining these results, we get 48 institutions with an annual income of $100,000 or more favoring examinations for all students at the same time, and 25 favoring an earlier date for senior finals. The practise of these institutions seems to be decidedly in favor of the former. It is of importance, too, to note that all of the colleges and universities in the country on private foundations and belonging to this group were heard from except two.

This table also shows that the practise of having senior finals at an earlier date is almost equal to the other method among the colleges and universities with an annual income of from $50,000 to $100,000, and that it reaches a majority of almost two to one among the institutions with an income of from $25,000 to $50,000 a year, or 40 per cent. of all the institutions of that class in the country. In the next lower income group, the ratio shifts back into approximate conformity with the highest income groups.

The distribution of these institutions according to the census divisions is rather suggestive in places. We need consider only the state universities and the groups of institutions on private foundations, except the lowest.

TABLE IX

Distribution of State Universities

		North Atlantic	South Atlantic	North Central	South Central	Western	Totals
Final examinations scheduled	For all students at the same time	2	2	10		3	17
	For seniors earlier		3	3	3	4	13
	Scattering[2]				1	2	3
Institutions not heard from			1	1	4	2	8
Totals		2	6	14	8	11	41

[1] "Scattering" means that the postals did not indicate clearly whether the examinations for seniors occurred earlier or not.

[2] "Scattering" means in Tables IX. to XIII. that the postals were indefinite on this point.

From Table IX. it is evident that in the North Central section where the state universities are most numerous, and each of them has an annual income of more than $100,000, there are 10 out of 14 that schedule the final examinations for seniors at the same time as for the rest of the students. Tables X. and XA, also, show that in the North Atlantic section where the colleges and universities of the highest income class are most numerous, 18 out of 28 follow the same practise, and 10 out of 12 is the ratio of these same institutions in New England. These institutions are, presumably, especially well equipped and committed to the highest educational ideals. Or to put the matter differently, 17 out of 41, that is, nearly a half of all the state universities in the country, and 32 out of 50, that is, much more than a half of all the colleges and universities of the highest income, set the senior finals at the same time as for the other students. This is certainly significant.

In Table XI. the situation is about evenly balanced, although the general results seem to be more in line with the two preceding tables than out of harmony with them.

If we turn, now, to Table XII., it is evident that about half of all the institutions of this class are in the North Central section, and that slightly more than a half of these set the senior finals at an early date. Or to put the matter differently, about two thirds, 20 out of 32, of all the institutions in the country of this class that reported this practise are in this North Central section.

TABLE X

Distribution of Colleges and Universities on Private Foundations with an Annual Income of $100,000 or More

		North Atlantic	South Atlantic	North Central	South Central	Western	Totals
Final examinations scheduled	For all students at the same time	18	4	7	1	2	32
	For seniors earlier	10	1	2	1		14
	Scattering			1		1	2
Institutions not heard from				1	1		2
Totals		28	5	11	3	3	50

TABLE XA

Special Analysis of the Distribution of Colleges and Universities on Private Foundations with an Annual Income of $100,000 or More in the North Atlantic Division

		New England	New York	New Jersey	Penna	Totals
Final examinations scheduled	For all students at the same time	10	6		2	18
	For seniors earlier	2	2	2	4	10
	Scattering				1	1
Institutions not heard from						
Totals		12	8	2	7	29

TABLE XI

Distribution of Colleges and Universities on Private Foundations with an Annual Income of from $50,000 to $100,000

		North Atlantic	South Atlantic	North Central	South Central	Western	Totals
Final examinations scheduled	For all students at the same time	7		8	2	2	19
	For seniors earlier	7	1	6		3	17
	Scattering	1		1		1	3
Institutions not heard from		3	1	1	1		6
Totals		18	2	16	3	6	45

TABLE XII

Distribution of Colleges and Universities on Private Foundations with an Annual Income of from $25,000 to $50,000

		North Atlantic	South Atlantic	North Central	South Central	Western	Totals
Final examinations scheduled	For all students at the same time	4	2	5	4	2	17
	For seniors earlier	3	6	20	2	1	32
	Scattering		1	4			5
Institutions not heard from		5	5	10	4	1	25
Totals		12	14	39	10	4	79

Table XIII. does not yield quite such distinct results as Table XII. and yet it points in about the same direction. About one half of all the institutions in this class are in the North Central section, and nearly one third of these have the senior finals early. Still further, 29 out of 50, about three fifths of all

the institutions of this class that reported early finals from all parts of the country are in this North Central division.

TABLE XIII

Distribution of Colleges and Universities on Private Foundations with an Annual Income of from $5,000 to $25,000

		North Atlantic	South Atlantic	North Central	South Central	Western	Totals
Final examinations scheduled	For all students at the same time..	4	8	36	10	7	65
	For seniors earlier.	5	10	29	5	1	50
	Scattering........	1	1	5	2	1	10
Institutions not heard from...		5	12	21	19	2	59
Totals.. . . .		15	31	91	36	11	184

The evidence is not absolutely conclusive and yet it tends to single out the North Central section as the home of this practise and among the colleges and universities with an annual income of from $5,000 to $50,000.

Turning, now, to the second phase of the entire problem, the results obtained by the first somewhat rough method are reinforced by this more analytical method. Of the 347 institutions heard from, 121, or a little more than one third, excuse seniors from final examinations. Of these, 71 are institutions with an annual income of from $5,000 to $50,000. Still further, while but 39 per cent. of all the colleges and universities of the country are in the North Central section, 50 per cent. of all that excuse from examinations are located there, and 70 per cent. of these, or 43 out of 61, are institutions with from $5,000 to $50,000 income a year. These results are evident from Table XIV.

TABLE XIV

Distribution of the Institutions which Excuse Seniors from Final Examinations. Most of them Arranged according to Income Groups

	North Atlantic			South Atlantic			North Central			South Central			Western			Totals[10]			Totals
	Final Examinations Scheduled			Final Examinations Scheduled			Final Examinations Scheduled			Final Examinations Scheduled			Final Examinations Scheduled			Final Examinations Scheduled			
	For All Students at Same Time	For Seniors Earlier	Scattering[9]	For All Students at Same Time	For Seniors Earlier	Scattering	For All Students at Same Time	For Seniors Earlier	Scattering	For All Students at Same Time	For Seniors Earlier	Scattering	For All Students at Same Time	For Seniors Earlier	Scattering	For All Students at Same Time	For Seniors Earlier	Scattering	
Schools of technology............					1			1	1								2	1	3
Agricultural schools..............		2			1			1	1					1			5	1	6
State universities................	1				1		2	1			2	1		1	2	3	5	3	11
State colleges..................		2												1			3		3
Universities and colleges on private foundations with an annual income of: $100,000 or more...	4	3	1				2		1				2			8	3	2	13
$ 50,000 to $100,000		2					3	1	1					1	1	3	4	2	9
$ 25,000 to $ 50,000	2	1			3	1	3	6	4	2						7	10	5	22
$ 5,000 to $ 25,000	2			1	6	1	16	9	5	2	2	2	2		1	23	17	9	49
Less than $5,000....					1								1			1	1		2
Not listed.........							1	1	1							1	1	1	3
Totals..........	9	10	1	1	13	2	27	20	14	4	4	3	5	4	4	46	51	24	121
Totals	20			16			61			11			13			121			

[9] "Scattering" means that these postals did not indicate the attitude of the institution toward earlier examinations for seniors or at the same time as other students. They did indicate clearly exemption from examinations under certain conditions.

[10] This is a summary of the respective columns read across the table.

To make this study more complete one would need to show the tendency, that is, whether the custom of setting senior finals at the same time as the finals for other students is increasing, or *vice versa,* and whether excusing seniors from finals is becoming more or less prevalent. The questionnaire did not provide for this aspect of the matter. It was arranged so as to elicit the information sought speedily, and with the least amount of effort on the part of college and university registrars to whom it was sent. This much, however, may be said. Three eastern institutions, each with an income of at least $175,000 a year, have tried the method of earlier examinations for seniors and have abandoned it. This was learned from other sources. One of the cards, also, indicated that an eastern institution in the $100,000 income class, which is now following that practise, is seriously considering a change to the method of scheduling the final examinations for all students at the same time.

In regard to excusing from examinations, it may be said that the return postals from two institutions indicated that they are contemplating adopting this method, but both are in the class with an annual income of from $5,000 to $25,000, and in the North Central section. Fifteen postals, rather evenly distributed throughout the country, indicated by such expressions as "Never," "All stand examination," "Not excused under any condition," "All must take both mid-year and final examinations," a decided opposition to any such practise.

A few institutions indicated that the difficulty of grading seniors carefully, when their examinations come at the regular time, just before commencement, is met by putting senior subjects, so far as compatible with a rather wide range of electives, early in the examination period, which, it was shown, extends through one or two weeks.

In attempting to state briefly what this study has shown, I may not assume that there is any method that may be regarded as absolutely best. A practise which is generally favored may not be the best. It is the small group of institutions, or a single institution, which *may* by experiment discover a method superior to one long tried and approved. None the less, the practise of a decided majority of the better equipped institutions, judging from their annual income, is very significant. That majority is 48 to 25, as given on page 182. While not final, their insistence upon scheduling senior examinations at the same time as for other students, and their tendency not to excuse seniors from the second semester or spring term examinations, the majority against being about the same as in the other case, would seem to indicate what is best at present.

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WILLIAM McMURTRIE[1]

William McMurtrie was born on March 10, 1851, on a farm near Belvidere, N. J. He was an active, energetic lad at school and at Lafayette College, where he entered in the mining engineering course in 1868, graduating in 1871. While in college he was a member of the Franklin Literary Society and of the Zeta Psi fraternity. Among his classmates were the late John Meigs, proprietor of the famous Hill School of Pottstown; Dr. W. B. Owen, a well-known and influential member of the faculty of Lafayette College; D. B. King, of New York City, and H. P. Glover, of Mifflinburg, Pa.

In 1872 McMurtrie became assistant chemist in the U. S. Department of Agriculture at Washington, D. C., Dr. R. J. Brown being the chief chemist. Dr. Wiley says:

[1] Several biographical notices of Dr. McMurtrie have already appeared—one by Dr. C. P. McKenna in *The Percolator,* issued regularly by the Chemists' Club of New York City (June 20, 1913), a more extended notice by Dr. H. W. Wiley in the *Journal of Industrial and Engineering Chemistry* (July, 1913, p. 616). The last named contains a bibliography by Douglas C. McMurtrie. I have drawn upon both these sources. The dates are from Dr. Stonecipher's "Bibliographical Catalogue of Lafayette College" and from "Who's Who in America."

On entering the laboratory, I found one assistant at work; a young man with jet-black hair and pleasing appearance, seated on a high stool before a desk, attending to some of the details of an analysis. . . . This was my first meeting with Dr. McMurtrie and the beginning of a friendship which continued unabated until the time of his death. . . . Within the next two years from the time of which I speak, Dr. Brown retired from the position of chief chemist of the Department of Agriculture and Dr. McMurtrie took his place. He was at that time, though only twenty-one years of age, well trained in chemistry, as training was regarded in those days. . . . When he entered Lafayette College there was no special course of chemistry, so he took mining engineering because in that he could have the best chemical training which the college afforded.

The story of how he was selected for the succession to Dr. Brown reveals one of the characteristics of his whole life, namely, unselfishness. Judge Watts was at the time Commissioner of Agriculture. When Dr. Brown retired a number of applications for this position came in. Commissioner Watts called young McMurtrie into his office and asked him what he thought of the qualifications of the applicants. He said he did not think any one of them was properly qualified for the position. Commissioner Watts then asked him if he thought he could do the work and would like the position. He replied that the idea of succeeding Dr. Brown had never entered his mind, but he thought he could do better than any of the men who were being considered.

In 1876 he married Helen M. Douglas, who with his son, Douglas C., survives him.

In 1878 he became agent of the U. S. Department of Agriculture and superintendent of the agricultural section at the Exposition Universelle at Paris. His account of the work is contained in the first volume of the Report of the U. S. Commissioners, page 113. An interesting confirmation of Dr. McMurtrie's modesty is to be inferred from a certain letter contained in the volume just cited from Mr. McCormick, Commissioner General, to Secretary Evarts, in which he states that "there is an eager movement upon the part of certain Americans here to secure decorations from the French government." Dr. McMurtrie's name does not appear in this list, but in 1883 he was made a Chevallier du Merite Agricola "because of service rendered in agriculture."

From 1879–1882 he was special agent of the Department of Agriculture in agricultural technology and wrote several valuable reports, only a part of which were published. Among these were reports on "The Mineral Nutrition of the Vine," "A Report on the Culture of Sumac in Sicily," on the "Culture of the Sugar Beet," on the "Examination of Raw Silks," and "A Report upon an Examination of Wools and other Animal Fibers." His reports upon "Sugar Beet Culture" and upon "Wool" are considered especially valuable. The subject last named he returned to, publishing two further reports in 1887 and 1901.

In 1882 McMurtrie became professor of chemistry at the University of Illinois at Champaign, in 1884 chemist of the Illinois State Board of Agriculture and in 1886 chemist of the Agricultural Experiment Station.

In 1888 he came to New York as chemist of the New York Tartar Company. He took charge of their factory in Brooklyn and revolutionized the methods of manufacture, trying one method after another until he finally succeeded in making perfectly pure cream of tartar and tartaric acid on a manufacturing scale at a reasonable cost. In further prosecuting the work of the Royal Baking Powder Company he organized a complete factory for making tin containers for their product. This was highly successful and is still considered a model factory for this purpose.

Dr. McMurtrie was very much interested in the reorganization of the American Chemical Society, which was undertaken in 1893 when Dr. Wiley became president. I was then editing the *Journal of Analytical and Applied Chemistry* and Dr. Wiley came to me with the suggestion that I had better either give up my own journal and run the *Journal of the American Chemical Society* as editor or edit both journals. I told him at once that I would decline the second proposition but would hold the first under advisement, and I finally consented. When the arrangement was concluded it was June. We had two papers and were six numbers in arrears. By the end

of the year twelve numbers had been issued and the membership had begun to increase. At that time, if my memory is correct, there were less than 500 members, many of whom were in arrears for dues. During my editorship, which continued for nine years, Dr. McMurtrie was a very active member of the council and in 1900 became president. He was ready to sacrifice his time and means in the service of the society and expected the rest of us to do as much. The salary list during these years was ridiculously small, yet a tremendous amount of work was accomplished.

Dr. McMurtrie was a man of fine presence, agreeable manners and great kindness of heart. He died May 24, 1913.

Edward Hart

PUBLICATIONS OF THE DEPARTMENT OF AGRICULTURE

The Secretary of Agriculture has announced new plans of publication work for that department. There has been an independent series of bulletins and circulars in each of the thirteen publishing bureaus, divisions and offices of the department. These have been discontinued and will be superseded by the *Journal of Research* for printing scientific and technical matter, and by a departmental series of bulletins, written in popular language for selected and general distribution. By this plan the confusion that has resulted from the multiplicity of series of publications will be avoided, and the saving of a considerable sum will annually be effected.

Under the new plan the department will discontinue the general distribution of matter so scientific or technical as to be of little or no use to the lay reader. It will supply technical information only to those directly interested and capable of using scientific analyses, and of understanding the results of research work couched in scientific terms. A larger amount of information in popular form which the average reader can immediately apply to his own direct advantage, and thereby increase the agricultural productiveness and the health of the nation, will hereafter be distributed.

The highly scientific matter heretofore published indiscriminately in bulletins and circulars will hereafter be published only in the newly established *Journal of Research*, which will be issued about once a month. It will be royal octavo, of the scientific magazine type, from 75 to 100 pages, 12 numbers to constitute a volume. Such of the matter in the *Journal* as seems to merit additional circulation may be issued in the form of reprints or separates. The *Journal*, for the present at least, will be limited to the publication of the results of research made by the various bureaus, divisions and offices, but it may be extended to include the scientific research work of the state agricultural experiment stations, in which event two editors representing these stations will be added to the editorial committee. Extensive scientific articles, embodying a complete report of research investigations, will be considered as monographs, and may be published as supplements to the *Journal*.

Permission will be given to specialists to publish technical reports or even monographs in journals of scientific societies or technical magazines specializing in highly restricted fields of scientific endeavor.

The *Journal* will be distributed free to agricultural colleges, technical schools, experiment stations, libraries of large universities and certain government depositories and institutions making suitable exchanges; also to a restricted list of scientific men. Copies of the *Journal* will be sold to miscellaneous applicants by the superintendent of documents, Government Printing Office, and possibly an annual subscription price will be affixed, as is done with the *Experiment Station Record*.

The *Monthly Crop Reporter* will no longer be published. The crop statistics will be collected as heretofore, and telegraphic and news summaries of these statistics will continue to be issued to the press. The printed *Crop Reporter* was discontinued because it did not bring the information into the hands of the recipients until from 10 to 17 days after the really important news had been circulated by telegraph and printed in the daily press throughout the United States and Europe, the statistical information, therefore, reaching the

actual crop correspondent and through him the local producer too late to be of practical service.

As a partial substitute for the printed *Crop Reporter*, a *Weekly News Letter* to crop correspondents will be issued in typewritten facsimile form. This can be prepared and put into the mails sooner than was possible with the printed *Reporter*. It is believed that the weekly news will be far more timely than notices issued heretofore only once a month. Its circulation will be limited to official crop correspondents. The *News Letter* will contain summaries of more important discoveries and recommendations of the various bureaus, divisions and offices.

The *Experiment Station Record*, the *Weather Review* and *North American Fauna* will continue to be issued with certain modifications. The *Yearbook* will be restricted to articles of the magazine type, which, it is believed, will add greatly to the popularity and value of the volume, of which 500,000 copies are printed and distributed annually.

In the department series of bulletins all the publications of the various bureaus, divisions and offices will be printed. These bulletins may be any size from 4 to 60 pages, and will be semi-technical or scientific, or popular in character. They will capitalize for popular use the discoveries of laboratories and scientific specialists.

The series of farmers' bulletins will be continued. The object of these bulletins is to tell the people how to do important things. The bulletins will contain practical, concise and specific and constructional statements with regard to matters relating to farming, stock raising, fruit growing, etc. Under the new plan the bulletins will be reduced in size to from 16 to 20 pages, and will deal particularly with conditions in restricted sections, rather than attempt, as heretofore, to cover the entire country. Much of the information calling for immediate circulation will be issued hereafter in the form of statements to the press instead of being held back as heretofore for weeks until a bulletin could be printed and issued. The publication of bulletins dealing with foreign crop statistics will be discontinued. Material of this character when deemed important will be furnished to the press for the information of the public.

Consideration is being given to the discontinuance of certain annual reports of bureaus now required by law to be printed, with the belief that much of the matter therein contained is unnecessary, while certain portions could be more advantageously and more promptly printed as bulletins of the department. All executive reports of chiefs are to be reduced with the object of confining them to strictly business reports.

The new plan of publication work has been designed primarily to improve the character of the department's publications, and secondarily to prevent waste in distribution, and through the economies effected, a greater output of information will become possible with the available appropriation. Certain changes will be made in the existing form of the publications, designed with a view to improving their appearance, reducing their size and adapting them to wider distribution.

SCIENTIFIC NOTES AND NEWS

Charles F. Marvin, professor of meteorology in the U. S. Weather Bureau since 1891, chief of the instrument division, has been appointed chief of the Weather Bureau, to succeed Mr. Willis L. Moore.

The council of the Royal College of Surgeons, London, has elected the following honorary fellows: Dr. Harvey Cushing, professor of clinical surgery at Harvard University; Dr. W. J. Mayo, surgeon at St. Mary's Hospital, Rochester, Minn., and Dr. George Crile, professor of surgery at Western Reserve University, Cleveland.

The trustees of the Beit memorial fellowships, on the advice of the advisory board, have decided to assist further research as to the nature of the virus of sand-fly fever, a disease which is the cause of much sickness in the ships of the Mediterranean Squadron and among the troops stationed at Malta and in certain parts of India and elsewhere. The

army council has approved of Captain P. J. Marett, R.A.M.C., who has already published papers on the subject, undertaking this research in addition to his military duties at Malta. Captain Marett will have the title of Beit Memorial Research Fellow.

MME. CURIE has been organizing a radium laboratory in Warsaw, but will return to her laboratory at the Sorbonne in the autumn.

DRS. WILLIAM H. WELCH and Lewellys F. Barker, of the Johns Hopkins University, have sailed for Europe.

DR. JOHN A. FERRELL has been appointed general manager of the hookworm work of the Rockefeller Foundation, with headquarters in Washington.

THE steamship *Eric*, taking the McMillan Crocker Land expedition into the arctic regions, reached Battle Harbor on August 3. She takes on board supplies and outfit landed from the disabled *Diana*, and expected to leave for the north on August 4.

MR. VILHJALMAR STEFANSSON cables to the New York *Times* that the *Karluk* and the *Mary Sachs* sailed from Port Clarence, Alaska, about midnight on July 23. "The *Alaska* will follow in four days and may overtake us near Herschell Island about the middle of August." There are fifteen scientific men and twenty-two others on the three vessels. The outfit is complete for two years, and may be made to last longer. No fear need be felt for the *Karluk* if she is not heard from for two years. The *Alaska* and the *Mary Sachs* should be heard from twice yearly, in October by whalers through Bering Straits, and in January by mounted police through Dawson.

DR. K. TH. PREUSS, of the Berlin Anthropological Museum, will undertake in September explorations in Colombia.

DR. R. S. BASSLER, of the National Museum, Washington, spent two days recently at the Oberlin Geologic Survey Camp at Rich Creek, Va., reviewing with them parts of the early and middle Paleozoic sections exposed in the vicinity. In the evening of July 25 he gave a lecture before the camp students on "Some Recent Developments in the Theory of Appalachian Stratigraphy."

IT was stated in a recent issue of SCIENCE that the Hon. James Wilson, lately Secretary of Agriculture, has been given the degree of doctor of science from the University of Edinburgh. The degree given was doctor of laws, the Scottish universities not conferring the degrees of doctors of science, letters or philosophy *causa honoris*, but only in course.

PROFESSOR M. A. ROSANOFF, of Clark University, has been invited to speak before the *Versammlung deutscher Naturforscher* at the University of Vienna, on the mechanism of esterification and esterhydrolysis. The conference will last from September 21 to 26. Dr. Rosanoff expects to sail on August 26 and to be back early in October. In course of the past academic year Dr. Rosanoff lectured on parts of the same subject before the New York and Northeastern Sections of the American Chemical Society, the research staff of the General Electric Company at Schenectady, the industrial research department of the University of Pittsburgh and the chemical department of Wesleyan University.

THE city authorities of Berlin propose to appropriate $250,000 for the erection of the Rudolf Virchow House for the Berlin Medical Society.

PROFESSOR JOHN MILNE, distinguished for his work in seismology, died at his home in the Isle of Wight, on July 31, aged sixty-three years.

PROFESSOR CHARLES SIMEON DENNISON, since 1885 professor of descriptive geometry and drawing in the University of Michigan, has died at the age of fifty-four years.

A MISCELLANY in honor of the sixtieth birthday of Dr. William Ridgeway, professor of archeology in Cambridge University, is in course of preparation and will be issued in October. The volume will contain some congratulatory verses by A. D. Godley, public orator in the University of Oxford, Greek verses by Professor John Harrower, a photogravure portrait of Professor Ridgeway, and a series of articles on classics and ancient arche-

ology, medieval literature and history and anthropology and comparative religion. In the latter subjects the contributions are as follows:

E. Thurston, "The Number Seven in Hindoo Mythology."

T. A. Joyce, "The Weeping God."

S. A. Cook, "The Evolution and Survival of Primitive Thought."

J. G. Frazer, "The Serpent and the Tree of Life."

W. Boyd Dawkins, "The Settlement of Britain in the Prehistoric Age."

W. Wright, "The Mandible from the Morphological and Anthropological Point of View."

C. G. Seligmann, "Ancient Egyptian Beliefs in Modern Egypt."

W. L. H. Duckworth, "Craniological Notes."

W. H. R. Rivers, "The Contact of Peoples."

J. Rendell Harris, "The Dioscuri in Byzantium and its Neighborhood."

C. S. Myers, "Primitive Music."

Henry Balfour, "Some Peculiar Fishing Appliances and their Geographical Distribution."

A. C. Haddon, "The Outrigger Canoes of Torres Straits and North Queensland."

J. H. Moulton, "Notes in Iranian Ethnography."

The British Board of Agriculture and Fisheries has awarded research scholarships in agricultural science of the annual value of £150, tenable for three years, to the following candidates, viz.: E. W. Barton (Wales), economics of agriculture; W. Brown (Edinburgh), plant pathology; Miss E. C. V. Cornish (Bristol), dairying; F. L. Engledow (London), genetics; E. J. Holmyard (Cambridge), plant nutrition and soil problems; R. C. Knight (London and Bristol), plant physiology; F. J. Meggitt (Birmingham), agricultural zoology; H. Raistrick (Leeds), animal nutrition; G. O. Sherrard (Dublin), genetics; T. Trought (Cambridge), genetics; G. Williams (Wales), animal nutrition; S. P. Wiltshire (Bristol), plant pathology; Miss T. Redman (London), dairying. The scholarships have been established in connection with the scheme for the promotion of scientific research in agriculture, for the purposes of which the treasury has sanctioned a grant to the board from the development fund; they are designed to provide for the training of promising students under suitable supervision with a view to enable them to contribute to the development of agricultural science.

The new Natural History Department of the Birmingham Museum and Art Gallery was formally opened on July 17. The museum, as we learn from *Nature*, comprises four galleries, one of which is not yet opened, having been reserved for the Beale Memorial Collection, which is to consist of nesting groups of British birds. The collections, which have been arranged by Mr. W. H. Edwards, contain representatives of most sections of natural history, though birds, shells and insects predominate at the present time.

The late Miss Henriette Hertz, who died at Rome on April 9, has, according to the London *Times*, left the following benefactions to the British Academy: £2,000 for an annual lecture or investigation or paper on a philosophical problem, or some problem in the philosophy of western or eastern civilization in ancient and modern times; £2,000 for an annual lecture or investigation or paper on some problem or aspect of the relation of art (in any of its manifestations) to human culture, art to include poetry and music as well as sculpture, painting; £1,000 for an annual public lecture on some master mind, considered individually with reference to his life and work, specially in order to appraise the essential elements of his genius, the subjects to be chosen from the great philosophers, artists, poets, musicians; £1,000, the income of which is to be used to promote the publication of some philosophical work to reward some meritorious publication in the department of philosophy. The testatrix has also left the sum of £1,500 to Girton College, the income to be used for the endowment of archeological research. Her main benefaction is devoted to the foundation of the "Bibliotheca Hertziana" in the Palazza Zuccari, for the promotion of Renaissance studies.

The inroads of the chestnut bark disease, or chestnut blight, on the chestnut trees of New England and the Middle Atlantic States

is resulting in the death of a great deal of chestnut timber. Officials of the U. S. Department of Agriculture recommend, to prevent the spread of the disease, that shipments of chestnut timber should include only material from which the bark has been removed and from which the diseased spots have been cut out. In the region affected there is a good market for all chestnut products except cordwood. The demand for poles and ties absorbs all that are offered, and lumber finds ready sale in local markets. Cordwood, however, is often a drug except within shipping distance of tanning extract plants, brass foundries, lime kilns, brick yards and charcoal plants. The question has arisen as to whether the disease-killed timber is less valuable than that from green trees. Strength tests made by the Forest Service indicate that sound wood from chestnut killed by the bark disease is as strong as that from green timber. The bark disease kills the tree by girdling the trunk, and does not cause unsound or decayed wood, which is the result of attack by fungi or insects. Until two years after the death of the tree the wood generally remains sound, though at the end of that time insects have commenced working in the sapwood. Three years after death the sapwood is honeycombed with insect burrows; in four years it has decayed, and begins to dry and peel off in the fifth year. After this the heartwood checks badly. To avoid loss, therefore, all timber should be used within two years after being killed. At a recent meeting in Trenton, N. J., foresters were present from most of the states in which the chestnut bark disease is prevalent. Connecticut, New Jersey, New York, Pennsylvania, Virginia, West Virginia, North Carolina, and the Forest Service and the Bureau of Plant Industry were represented. Representatives of the states approved the investigations undertaken by the Forest Service, and recommended that the individual states give particular attention to the development of local markets for stands of blight-killed chestnut. Owners of such timber should apply to the state foresters or to the Forest Service for further information upon the uses and markets for chestnut.

WE learn from *Nature* that a large number of distinguished physiologists, biologists and medical men have signed a letter addressed to the home secretary directing attention to the scientific aspects of the administration of the Mental Deficiency Bill. The signatories desire to secure the continuous prosecution of research into the conditions on which mental deficiency depends, and into the means by which it might be remedied or prevented. They point out that it may be said, in a general way, that the conditions in question must be due either to defective formation and development of the active structures of some portion or portions of the brain, or to defective formation or supply of the fluids by which these structures are surrounded, and by which they are stimulated to activity. For example, one common form of idiocy is consequent upon the absence from the blood of the secretion which should be furnished by the thyroid gland, and may be remedied by the administration of thyroid extract derived from lower animals. The Mental Deficiency Bill will probably bring together many of its subjects into institutions controlled by the state, and supported by the public. It is therefore urged that the facilities for scientific study which such institutions would afford should be fully utilized for the general benefit of the community, and that the duty of so utilizing them should be committed to men of science, fully conversant with all that is already known in relation to the subject, and able to point out the directions in which further inquiry should be pursued. It is suggested that the objects in view could scarcely be obtained except by an adequate representation of biological science upon any commission to which the administration of the law may be entrusted.

AN agricultural colony in Palestine has applied to the U. S. Forest Service for help in planting trees to bind the drifting sands of the Mediterranean. The colony is near Jaffa, or Yafa, the ancient Joppa of the Bible, and there is being developed in connection with it a seaside resort, with hotel, villas, bath houses and gardens. The experts of the service point out that the reclamation of sand dunes is not a serious problem in the eastern

United States because the prevailing winds are from the land and the sand is blown into the sea. On the west coast the situation is more serious. The most notable example of reclaimed sand areas there is furnished by Golden Gate Park, San Francisco, where grasses, acacias and, later, trees and shrubs have converted sand wastes into pleasure grounds of great beauty. The attention of the Palestine colony is called to the wonderful reclamation of the Iandes, France, where a wealth-producing forest of maritime pine, the source of the French turpentine, has been grown to take the place of shifting dunes. The American foresters also give the address of the French seedsman who furnished this government with the maritime pine seed which has been used in planting experiments on the Florida national forest, near the Gulf coast.

The Secretary of Agriculture has signed an agreement with the state of North Carolina for a cooperative study of forest conditions in the eastern piedmont region. The work will be carried on by the forest service and by the state geological and economic survey with one half of the cost paid by each. The study will determine the distribution and proportion of forest lands, and the relative value of lands for timber and for agriculture. It will take into account the present status of lumbering, the causes and effects of forest fires, and will recommend a system of fire protection and of forest planting. The study arranged supplements two already completed in the more mountainous regions of the state. The first, a study of forest conditions in the Appalachians, has been published as a state report. A study of the forests of the western piedmont region was completed recently and the results are being prepared for publication. When the study of the eastern piedmont region is finished it is planned to proceed to a similar study of the coastal plain region, so that eventually the entire state will be covered by a forest survey.

UNIVERSITY AND EDUCATIONAL NEWS

Governor Tener, of Pennsylvania, has, after revision, approved the following state appropriations made at the last session of the legislature: The Pennsylvania State College, $1,240,000, in addition to income from Land Grant Fund and congressional appropriation to Land Grant Colleges; University of Pennsylvania, $820,000; University of Pittsburgh, $400,000 and Temple University, $100,000, making the total state appropriation for higher education $2,560,000.

Franklin College, Indiana, has secured pledges aggregating two hundred and fifty thousand dollars for additional endowment. Three sixteenths of this amount is from the General Education Board.

Middlebury College has received $30,000 as the residuary legatee of the late Henry M. Barnum.

Sir William Ramsay, emeritus professor in University College, London, has given the college £500 for books and journals for the chemical library.

The medical department of Tulane University will hereafter be known as the Tulane College of Medicine and will be divided into four schools, each with a separate dean and staff, namely: the School of Medicine and Pharmacy, dean, Dr. Isadore Dyer; the Post-Graduate School, dean, Dr. Charles Chassaignac; the School of Hygiene and Tropical Medicine, dean, Dr. Creighton Wellman, and Dentistry, dean, Dr. Andrew Friedrichs. The following elections and changes have been made in the Post-Graduate School: Dr. Henry Dickson Bruns, transferred from the emeritus to the active list, as professor of diseases of the eye; Dean Creighton Wellman, elected professor of tropical diseases and preventive medicine; Dr. J. T. Halsey, elected professor of clinical therapeutics; Dr. C. C. Bass, elected professor of clinical microscopy; Dr. W. W. Butterworth, elected professor of diseases of children, and Dr. George S. Bel, elected professor of internal medicine.

Professor W. A. Stocking, Jr., of the dairy department of the New York State Agricultural College at Cornell University, has been appointed to succeed Dr. L. H. Bailey as acting director of the Agricultural College.

Mrs. Ella Flagg Young has withdrawn her resignation as superintendent of the Chicago

public schools, the newly organized school board having declined to accept it, by vote of fourteen to one.

Dr. Arthur D. Hirschfelder, of Johns Hopkins Medical School, has accepted the appointment of professor of pharmacy and director of the pharmaceutical department of the University of Minnesota.

Dr. J. M. Slemons, associate professor of obstetrics at Johns Hopkins Medical School, has been appointed head of the department of obstetrics and gynecology and director of the woman's clinic in the University of California.

Mr. Harold S. Osler has been elected assistant professor of agronomy, in charge of the crops section at the University of Maine.

Mr. J. B. Demaree, recently of the Ohio Agricultural Experiment Station, and for the last six months engaged in the study of plant rusts at the Indiana Experiment Station, has accepted a position in the State College of Pennsylvania as instructor in botany.

Professor Kruse has accepted the call as director of the Hygienic Institute at Leipzig as successor of Professor Hofmann.

DISCUSSION AND CORRESPONDENCE

THREE ICE STORMS

During the last two weeks in February, 1913, two ice storms which were of rather unusual meteorological interest, were observed at Blue Hill Observatory (10 miles south of Boston, Mass.). An "ice storm" (glatteis, verglas) occurs when raindrops falling on trees and other objects, cover them with ice. In both cases the ice storms began at the base station (400 feet below the summit and one half mile northwest) nearly three hours earlier than at the summit. The first ice storm occurred during the night of February 16–17. Throughout the sixteenth at the summit of Blue Hill, the wind was southerly, with the temperature in the forties (F.). In the middle of the afternoon, a low fog appeared over Boston. By sunset, this fog filled the entire Boston basin and was beginning to send long fingers southward through the notches in the Blue Hill Range and up the low Neponset Valley. Not till three hours later did the fog overtop Great Blue Hill with its accompanying northeast wind and freezing temperature. The warm south wind, whose lower boundary had now risen above the hill, continued above the lower wedge of cold air and with its rain supplied the material for the ice storm below.

The second storm began in the morning, February 27, and continued for twenty-four hours, the ice attaining a thickness of one inch. The night before, at a temperature of 26° a fine thick snow had set in with a brisk southeast wind. In the early morning, the temperature passed 32°, the snow changing to rain. At 5:20 a.m. the first influence of a cold current of air from the north was recorded on the thermograph at the base station (temperature fell rapidly from 35° to 31°). Not till 8:15 a.m. did the wind on the summit swing to the north, lowering the temperature to that of the base station. The warmer air current continued above, unabated, for at 9 p.m. the light rain had become heavy (rain temperature 32.3°) and the cold, northeast wind (27°–31°) had increased to brisk. On the following morning in the warm sunshine and rapidly rising temperature, the ice melted off the trees so rapidly that for half an hour the sound of falling ice resembled that of a heavy hailstorm.

Another ice storm deserving mention here was that of February 21–22. The weather map of February 21 showed an ice storm in progress over a strip of country 100–200 miles wide, extending from northern Texas to southern Michigan. The next morning, this ice-storm belt was shown as a strip about forty miles wide from northern Vermont to southern Maine. The geographical distribution of the different forms taken by the heavy precipitation throughout New Hampshire was particularly interesting as viewed from a train window two days later. At Jackson, N. H., the precipitation on February 22 had been about seven inches of snow and one inch of ice pellets. Southward, this snow-covering decreased rapidly into a thin, compact blanket of ice pellets and frozen rain, ice appearing on

the trees within 20 miles south of Jackson. At 40 miles south of Jackson, the smaller trees were so loaded with ice that they were bent to the ground and many branches had been broken off. Ten miles farther south, at Rochester, N. H., there was no more ice on the trees nor snow or ice on the ground. This great difference in ice and snow covering was the result of a difference in temperature of not more than 5° (31° Jackson, 33°–40° Blue Hill).

In each of these three cases the daily weather maps showed an area of high pressure ("high") directly north of a low pressure area ("low"), both moving slowly eastward, each more or less in the way of the other because of the prevailing tendency of a "high" to move east-southeast and of a "low" to move east-northeast in these parts of the United States. These cyclones ("lows") were thus amply supplied with cold air in their northern quarters. The ice storms occurred in the region where the normal warm southerly winds on the east side of the cyclones overlapped the cold north and northeast winds on the northern side.

Charles F. Brooks
Blue Hill Meteorological Observatory

A PHLEBOTOMUS THE PRACTICALLY CERTAIN CARRIER OF VERRUGA

Experiments on laboratory animals with bloodsucking arthropods, looking to the solution of the problem of verruga transmission, have been under way at Chosica, Peru, in charge of the writer, since May 15, 1913. A study of the bloodsuckers occurring in the verruga zones has been going on for a longer time. At first the writer strongly inclined to the theory of tick or other acarid transmission, but the trend of the investigation has been to make such transmission seem very improbable of late. No argasid ticks have been found to occur commonly on mammals in the verruga zones, and ixodid ticks will hardly explain the night infection. The experiments in feeding, biting and subcutaneous injection of animals with the bloodsucking Gamasid mites of the vizcacha, which seemed at first most promising, have so far entirely failed of result. A resurvey of the situation had therefore become necessary in order to start out on new lines.

Culicids, *Simulium*, Tabanids, *Stomoxys*, fleas, lice and bugs are all precluded either by their extended occurrence, by their dependence on man, or by their day-biting proclivities. The question of punkies and like small gnats remains. The writer's attention has recently been drawn to the possibilities of *Phlebotomus*, chiefly through the investigations recently published by Marett on the genus in the Maltese Islands. His results are most impressive and suggestive in this regard. The habits of the early stages and of the flies, as described by Marett, fit so well into the conditions obtaining in the verruga zones that the conclusion was irresistible that a *Phlebotomus* must be the carrier of verruga. Hitherto there has been no record of the occurrence of *Phlebotomus* in Peru, or anywhere in the Pacific coast region of South America.

Ceratopogon and other genera of Chironomidæ with mouth-parts more or less adapted for bloodsucking occur at night both in and out of the verruga zones. They were therefore contraindicated. Night collecting at Chosica, just below the limits of the verruga zone, has never disclosed *Phlebotomus*, and as these gnats are never seen under ordinary circumstances in the daytime the writer determined to investigate the verruga zone by night in order to demonstate if possible the existence of *Phlebotomus* therein. Accordingly he passed the night of June 25, 1913, at San Bartolomé in the verruga zone of the Rimac valley. The result was that, besides *Ceratopogon* and other Chironomids, several specimens of *Phlebotomus* were actually found. The natives call all nocturnal gnats *titira*, considering that most of them bite, but certain of the more intelligent distinguish the true *titira* as the *Phlebotomus* sp., stating that it has white wings.

The true explanation of the oft-repeated facts that verruga is confined to deep and narrow canyons, with much vegetation, heat and little or no ventilation, evidently lies here. The flies of *Phlebotomus* avoid wind, sun and full daylight. They appear only after sunset,

and only then in the absence of wind. They enter dwellings if not too brightly lighted, but are not natural frequenters of human habitations. They breed in caves, rock interstices, stone embankments, walls, even in excavated rock and earth materials. The verruga canyons contain ideal conditions for such breeding. They hide by day in similar places or in shelter of rank vegetation. Deep canyons, free from wind and dimly lighted, are especially adapted to them. Thick vegetation protects them from what wind there is by day or night. This explains the very peculiar restricted distribution of verruga both local and altitudinal. The flies suck the blood of almost any warm-blooded animal, and even that of lizards in at least one known case. Thus they are quite independent of man, and this accords with the verruga reservoir being located in the native fauna. The habits of *Phlebotomus* correspond throughout so minutely with the conditions of verruga and the verruga zones that the writer wishes to announce his entire confidence in the belief that the transmission experiments, now about to be initiated with these gnats on laboratory animals, will demonstrate their agency in the transmission of the disease.

CHARLES H. T. TOWNSEND

CHOSICA,
June 29, 1913

SCIENTIFIC BOOKS

Examination of Waters and Water Supplies. By JOHN C. THRESH. Second edition. Philadelphia, P. Blakiston's Son & Co. 1913. 644 pages; 36 plates; 16 illustrations in the text. Price $5.

This is a new edition of a book that is well known to American waterworks engineers. The author is one of the foremost water analysts in England and the book shows evidences that it is written by one who speaks with authority. It is needless to describe the book in detail.

Part I. relates to the examination of the sources from which water is derived. Part II. treats of the various methods of examining water and the interpretation of the results of such examinations. Part III. describes in more detail the analytical processes and methods of examination.

Most American readers will be particularly interested in the first three chapters that relate chiefly to ground water. The author describes numerous personal experiences in the detection of underground pollution, and an excellent description is given of the use of fluorescein, and other substances which may be detected either by sight or by smell, in tracing the course of water through the ground. From his experience he states that water which enters a dug well at a depth of six to twelve feet, depending upon the porosity of the soil, is usually efficiently filtered and purified. Water entering at a less depth is nearly always liable to be imperfectly purified and unsatisfactory in quality. The nearer the ground surface at which water can enter the greater the danger of pollution.

One statement of the author will strike most readers with surprise, namely, "Every known fact with reference to typhoid fever epidemics indicates that the typhoid bacillus alone is not the cause of disease, and it has long been suspected that some other organism either by itself or in conjunction with the typhoid bacillus was the cause." He then quotes from an article in the *Lancet* and describes a new anaerobic bacillus which has been found only in the feces of typhoid fever patients and which is agglutinated by their serum. It is a spore-bearing organism and is said to be capable of retaining its vitality for a very long period.

An interesting example of the growth of organisms in water mains is mentioned. A thirty-six-inch main at Hampton-on-Thames was recently taken up and found to contain fresh-water mollusks to such an extent that its bore was reduced to nine inches. It was estimated that ninety tons of mussels were removed from a quarter of a mile of this main.

Reference is made to the ill effect of the continued use of soft waters on the human system, and a method of artificially hardening water by the addition of calcium chloride and sodium bicarbonate is described.

Dr. Thresh makes occasional reference to permutit for purposes of water softening and recommends its use where the quantity of water to be treated is not large. This substance is coming into vogue both in this country and in Europe. By its use carbonates and sulphates of soda are substituted for the corresponding salts of lime and magnesia.

In discussing lead poisoning it is said that "no water acts upon lead unless both carbon dioxide and oxygen are present. It seems probable that when carbonic acid is in a certain excess a solvent action is exerted, whereas when oxygen is in excess the action is erosive."

The author's treatment of the biology of water is somewhat less detailed than that of its chemistry, but some experiences are related by him which are of interest, as, for example, the effect which the process of water softening has in reducing the number of bacteria in water. The bacteriological discussion is materially strengthened by quotations from Dr. Houston's answers to two specific questions, namely, "What bacteriological proof would you consider conclusive as to the pollution of a water with sewage, or manurial matter, and what bacteriological proof would you consider conclusive that a water is free from such pollution or so free that it is safe for drinking purposes"? The answers to these questions can not be stated in a few words, but Dr. Houston apparently regards a water which never contains *B. coli* in 100 c.c. as safe for drinking; a water which contains *B. coli* in 100 c.c. in less than half the number of samples examined as probably reasonably safe; but a water which contains *B. coli* in 100 c.c. in a majority of samples is one to be viewed with some degree of disfavor. Waters containing *B. coli* in smaller amounts in a majority of samples can not perhaps with absolute certainty be classed as sewage polluted, but the presumptive evidence increases to a more than proportional extent as a 10, a 1 and a 0.1 c.c. standard is infringed. Dr. Houston's standards appear to be somewhat more strict than those commonly discussed in this country.

The section of the book which describes in detail the mineral constituents of the alkaline waters of the London basin is interesting to analysts. More than four hundred of these analyses are given in detail.

In regard to the methods of analysis little need be said. They do not differ materially from those described in the first edition of the book and represent the ordinary English practise.

GEORGE C. WHIPPLE

HARVARD UNIVERSITY

Herbals, their Origin and Evolution. A chapter in the History of Botany. 1470–1670. By AGNES ARBER. Cambridge, the University Press. 1912. Octavo. Pp. xviii + 253.

The reason for writing this book is well stated by the author in her preface as follows: "My excuse must be that many of the best herbals, especially the earlier ones, are not easily accessible, and after experiencing keen delight from them myself, I have felt that some account of these works, in connection with reproductions of typical illustrations, might be of interest to others." A little later she says more specifically: "The main object of the present book is to trace in outline the evolution of the *printed herbal* in Europe between the years 1470 and 1670; primarily from a botanical, and secondarily from an artistic, standpoint."

In carrying out this object the author divides her book into nine chapters, whose headings will give a fair idea of its scope, as follows: I. The Early History of Botany (9 pages); II. The Earliest Printed Herbals (23 pages); III. The Early History of Herbals in England (12 pages); IV. The Botanical Renaissance of the Sixteenth and Seventeenth Centuries (72 pages); V. The Evolution of the Art of Plant Description (15 pages); VI. The Evolution of Plant Classification (20 pages); VII. The Evolution of the Art of Botanical Illustration (50 pages); VIII. The Doctrine of Signatures, and Astrological Botany (17 pages); IX. Conclusions (6 pages). In addition there are two appendices, I., containing a Chronological List of the Principal

Herbals and Related Botanical Works Published between 1470 and 1670 (14 pages), and II., containing A List in Alphabetical Order of the Principal Critical and Historical Works dealing with the Subjects Discussed in this Book (6 pages). A good index completes the volume.

In the first chapter we find some suggestive sentences. "From the very beginning of its existence, the study of plants has been approached from two widely separated standpoints—the philosophical and the utilitarian. Regarded from the first point of view, botany stands on its own merits as an integral branch of natural philosophy, whereas from the second it is merely a by-product of medicine or agriculture. This distinction, however, is a somewhat arbitrary one; the more philosophical botanists have not disdained at times to consider the uses of herbs, and those who entered upon the subject with a purely medical intention have often become students of plant life for its own sake. At different periods in the evolution of the science one or other aspect has predominated, but from classical times onwards it is possible to trace the development of these two distinct lines of inquiry, which have sometimes converged, but more often pursued parallel and unconnected paths." From which it will be seen that the advocates of "practical" botany to-day are but the modern representatives of the utilitarian schoolmen of the past.

The earliest printed book containing "strictly botanical information," we are told, was a work by Bartholomew, "Liber de Proprietatibus Rerum," which appeared about 1470. Quotations of text or figures are given from the "Ortus Sanitatus" (1491), "The Grete Herball" (1526), Brunfels's "Herbarum vivae Eicones" (1530), Turner's several works (1538–1551), Gerard's "Herball" (1597), the works of Bauhin, Dodoens, Lobelius and many others. The illustrations are most interesting, as showing the development of scientific drawing. Some of the earlier representations of plants were little more than *suggestions* of their appearance (and often of habitat, also), while others, though crude, actually gave a good idea of the characteristic appearance of the plants. The early artists appear to have conventionalized many of their drawings after fashions of their own, then perhaps familiar to the reader, but now not understood.

The chapter on the Doctrine of Signatures (VIII.) will repay reading, especially by the younger school of botanists of to-day. Will the time ever come when the botanists of some later century will look back to *our* beliefs with feeling similar to those we have when we read about the doctrine of signatures?

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Vergleichende Physiologie Wirbelloser Tiere. Von Professor Dr. H. JORDAN. Erster Band, Die Ernährung. Jena, Gustav Fischer. 1913. 8vo. Pp. xxii + 738, 277 text-figures.

There is no telling to what extent our libraries will need enlargement if Professor Jordan carries to completion his encyclopedic "Physiology of Invertebrates," for the 738 pages on Nutrition are to be followed by sections on Respiration, Metabolism, Excretion, Movement, the Nervous System, the Sense Organs and "Psychology."

Excluding the vertebrates, except for the necessary comparisons, and omitting entirely the physiology of reproduction, the plan, as outlined, is to present, with "the greatest unity attainable, a 'biological' treatment of the sum total of the phenomena that make up the life of the individual."

The first installment of this full-grown undertaking begins with a definition of life to which we can not subscribe, and a scene of some comic value in which teleology is shown the door, but asked to leave behind her extremely useful vocabulary. After this follows a systematic treatment of the phenomena of nutrition in all the usual groups of invertebrates, the material under each type or subtype being conveniently divided so that a discussion of the food, together with its modes of capture, always precedes an analysis of the various digestive processes and a discussion of the origin and nature of the involved se-

cretions. These topics in turn are followed by sections on absorption, the elimination of wastes, metabolism, reserve stuffs, and the phenomena of starvation. This list of regulars, now and again is lengthened to accommodate some special structural or functional relation.

Professor Jordan's work inevitably courts comparison with Winterstein's great cooperative handbook, but unfortunately both are incomplete, and the contrast between them in their present state is more apparent than real, for in Winterstein the section on the nutrition of invertebrates is also the product of a single pen. For the present, therefore, the relative merits of team work *versus* individual play in the production of physiological encyclopedias must remain uncertain.

On the whole, Winterstein offers more of immediate interest to the general physiologist, nevertheless, the space devoted by Jordan to comparable sections is nearly the same. Possibly some day some one may read one or the other from cover to cover, but the normal function of each of these books will probably be that of a Thesaurus to be tapped when occasion requires.

Jordan makes access to the wealth of material treated by him more convenient than Winterstein, not only on account of a greater regularity of treatment, but by the employment of heavy-typed captions of various sizes, together with elaborate subject and author indices for which we are not made to wait until the bitter end.

No work of this character ever comes off the ways without its share of misprints, mislabeled figures, misinterpretations, misquotations and sins of omission as well as commission. Numerically most of these types of defect fall well below the average, though one of them is quantitatively as well as qualitatively thoroughly characteristic of the great German text, for it appears to be a law of nature that the mind of the continental bookmaker is selectively impermeable to the efforts of American investigators. This is as true of Jordan as it is of his predecessors, and in consequence there is no group treated by him which here and there could not have been treated a bit better if he had drawn a little on our experience. Considering the numerous phases of nutrition in invertebrates and the number of Americans who have devoted years to the study of special groups, the omission of some of them, or the bare mention of others, shows that our work either does not reach the European, or is not assessed at the value placed upon it here. This may apply justly to some of our work; on the other hand, the discounts levied against certain men who might be mentioned are absurd.

The attempt to cover single-handed a field as large as the physiology of invertebrates is not symptomatic of the age, but the attempt to do so at all certainly is. Whoever knows the highly dispersoid condition of the literature and realizes how largely observation and experiment have been incidents in the work of morphologists and systematists, knows also the value of a reliable inventory of the facts. The importance of this for any special physiology needs no comment, whereas to those who agree with Winterstein that comparative physiology should be an independent science, rather than a method, the whole matter is obvious. However, we may relate special, comparative and general physiology, Jordan's book, like Winterstein's, will do good, but in a somewhat different manner, for it is aimed more directly at teachers of zoology, and for them appears admirably suited.

One of the worst faults of zoological courses on invertebrates is their over-emphasis of structure, a method grounded historically, and based on the belief that the best scientific use to which an organism can be put is to determine its relatives. No doubt this is important, yet how the related things manage to live is also worth knowing. With its well-organized material and superior illustrations Jordan's book shows beautifully how anatomy and physiology can be taught as one subject. "Proofs of Evolution," "Evidences of Relationship" and "Bases of Classification," however, will not readily cede their places, but

much to enliven and augment them will be found in a book which modestly attempts to lay the foundations of a phylogeny of physiological processes. In the concluding chapter occur, among others, generalized summaries of the three principal methods of food intake; an interesting section on salivation with its numerous differentiations; and a phylogeny of the ferments in which trypsin or trypsin-like substances are held to be the oldest. Other matters considered in the final chapter are genetic comparisons of the histological processes involved in secretion and absorption, the fate of absorpta, and finally a discussion of "the liver question," especially interesting to those who question the validity of christening invertebrate organs according as their color, form or location happens to resemble something or other in a vertebrate. This section is summed up in the following paragraph:

"The specialization of a stomach with the secretion of free acid and the necessary pepsin, the formation of special glands, segregated from the digestive epithelium, though pouring their juices into the alimentary tract, the occurrence of a liver correlated with digestion, and finally complicated regulations in the functions of these organs; all this distinguishes the digestive processes of vertebrates from those of invertebrates."

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May 13, 1913

Die sanitarisch-pathologische Bedeutung der Insekten und verwandten Gliedertiere, namentlich als Krankheits-Erreger und Krankheits-Uberträger. By EMIL A. GÖLDI. Berlin, R. Friedländer & Sohn. 1913. Pp. 155, Figs. 171.

The present small volume which contains a general account of the habits of insects in their relation to diseases is based on material presented by Professor Göldi in a course of lectures which he has been giving for a number of years in the University of Bern.

In spite of its limited size it gives a very good presentation of such facts as can be satisfactorily included in a university course on insects and diseases, and is much better suited for the general student than those portions of the text-books on tropical medicine that are devoted to insects. Its value lies mainly in the fact that the subject is considered primarily from the biological rather than the medical standpoint, and consequently in a more connected and intelligible way for this class of students.

The subject matter is perhaps somewhat different than would be indicated by the title, as much emphasis is laid upon insects which live partly or entirely as parasites of man and domestic animals, to which is added a supplementary discussion of their relation to the transmission of disease. The material is divided into three chapters: first, stinging, biting and caustic insects; second, insects and related Arthropods of parasitic habits; and third, insects and other Arthropods as carriers of disease. The first section is quite fully treated, but the bulk of the text is devoted to the second section, and the third receives rather brief consideration. One might wish that the portion relating to insects as carriers of various infections had been presented in more complete form, but this omission is more apparent than real, for the second chapter contains much material (*e. g.*, the development of trypanosomes) which one might expect to find in the third.

Göldi describes the morphology and physiology of the poison apparatus in the Hymenoptera, scorpions, centipedes and Hemiptera and points out the probable functions of the poison glands in different groups. Thus in the Hemiptera, spiders and centipedes, the so-called poison has apparently been developed as a digestive fluid. He is inclined to believe also that the venom of the scorpion has a digestive function in addition to its poisonous properties. Following this is a discussion of insects, mainly caterpillars of various kinds, that are provided with poisonous bristles or spines which cause irritation to the skin. Numerous species are figured, including a considerable number from equatorial America.

The section devoted to parasitic insects and other Arthropods opens with an account of mosquitoes which covers some twenty pages and contains in addition to general matter much valuable information on the carriers of malaria and yellow fever, and on other mosquitoes of the Amazonian region, based on original observations made by the author. Following this is a similar but shorter discussion of the gad-flies (Tabanidæ), the blood-sucking Muscidæ, Simuliidæ, Chironomidæ and Psychodidæ. The phlebotomic members of these families are spoken of by Göldi as habitual (professionelle) blood-suckers and hemiparasites (Halbparasiten) in distinction of other wholly parasitic forms (Ganzparasiten) which remain on the host during their entire life, or at least during their preparatory stages. Following this is an account of the more highly modified Diptera Pupipara and the fleas, the latter being treated at some length. The sucking lice are briefly mentioned as well as bedbugs and a few other blood-sucking Hemiptera. Ticks and mites follow, the mites receiving by far more space in proportion to their importance as disease carriers. Under the heading of myiasis are described many of the Diptera which develop regularly or occasionally as internal parasites of man and other mammals.

The third chapter on "Insects and Related Arthropods as Carriers of Disease" deals with the distribution and manner of transfer of insect-borne diseases, as well as with the morphology and life-cycles of a number of the causal microorganisms, such as the malarial parasites, trypanosomes, filarias, etc.

The volume is profusely illustrated by 171 text-figures, mainly in half-tone, derived from various sources with a smaller number of original figures. All are well selected, but many are inferior to those in the original works from which they have been copied. Some of the names applied to the insects mentioned are rather antiquated; thus one sees *Lucilia macellaria* and *Musca vomitoria* appearing in the text in place of generic names which have been used for many years. In the description of Fig. 103, representing some North American ticks, there is an unfortunate confusion of names, where *Dermacentor venustus*, the vector of Rocky Mountain spotted tick fever, is referred to as the "gefleckte Texasfieberzecke des Felsengebirges" (Rocky Mountain spotted Texas-fever tick). This species has, of course, no connection with Texas fever of cattle.

The text is well printed, furnished with a good index, and shows only a small number of typographical errors. So far as the reviewer can judge, there are no serious errors of statement, although some parts, such as those on the food and anatomical characters of the larvæ of *Stomoxys calcitrans*, are open to some criticism.

The book is one which may well be placed in the hands of students as a text, and it is to be hoped that its author may later see fit to enlarge it into a more extended treatise.

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SCIENTIFIC JOURNALS AND ARTICLES

IN January, 1913, *The American Mathematical Monthly* passed into the control of an editorial board consisting of representatives of twelve supporting universities and colleges in the middle west, together with B. F. Finkel, founder of the *Monthly* and editor since its inception in 1894.

It is the editorial policy of this journal to appeal especially to teachers of mathematics in the collegiate and advanced secondary fields, not only for the purpose of directing attention to questions of improvement in teaching in these fields, but also to foster the development of the scientific spirit among large numbers who are not now reached by the more technical journals.

A selection from the Tables of Contents of the first six numbers includes articles on—

The History of Mathematics, such as the following:

"History of the Exponential and Logarithmic Concepts," by Professor Florian Cajori, of Colorado College.

"The Foundation Period in the History of

Group Theory," by Josephine Burns, graduate student at the University of Illinois.

"Errors in the Literature on Groups of Finite Order," by Professor G. A. Miller, University of Illinois.

Pedagogical Considerations, such as the following:

"The 'Foreword' concerning Collegiate Mathematics," by Professor E. R. Hedrick, University of Missouri.

"Mathematical Literature for High Schools," by Professor G. A. Miller.

"Minimum Courses in Engineering Mathematics," by Professor Saul Epsteen, University of Colorado.

"Incentives to Mathematical Activity," by Professor H. E. Slaught, University of Chicago.

General Mathematical Information, such as the following:

"The Third Cleveland Meeting of the American Association for the Advancement of Science," by Professor G. A. Miller.

"Western Meetings of Mathematicians," by Professor H. E. Slaught.

"Notes and News" of events pertaining to mathematics, under the direction of a committee of which Professor Florian Cajori is chairman.

"Book Reviews" and announcements of new books in mathematics, under the direction of a committee of which Professor W. H. Bussey, University of Minnesota, is chairman.

Topics Involving a Minimum of Technical Treatment, such as the following:

"Maximum Parcels under the New Parcel Post Law," by Professor W. H. Bussey.

"Precise Measurements with a Steel Tape," by Professor G. R. Dean, Missouri School of Mines.

"A Direct Definition of Logarithmic Derivative," by Professor E. R. Hedrick.

"A Simple Formula for the Angle between Two Planes," by Professor E. V. Huntington, Harvard University.

"Two Geometrical Applications of the Method of Least Squares," by Professor J. L. Coolidge, Harvard University.

"Problems Proposed and Solved," under the direction of a committee of which Professor B. F. Finkel, Drury College, is chairman.

Topics Involving Somewhat More Technical Treatment, designed to stimulate mathematical activity on the part of ambitious students and teachers; for example, such as the following:

"The Remainder Term in a Certain Development of $F(a+x)$," by Professor R. D. Carmichael, Indiana University.

"A Geometric Interpretation of the Function F in Hyperbolic Orbits," by Professor W. O. Beal, Illinois College.

"Certain Theorems in the Theory of Quadratic Residues," by Professor D. N. Lehmer, University of California.

"Some Inverse Problems in the Calculus of Variations," by Dr. E. J. Miles, Yale University.

"Amicable Number Triples," by Professor L. E. Dickson, University of Chicago.

H. E. SLAUGHT,
Managing Editor

BRANCH MOVEMENTS INDUCED BY CHANGES OF TEMPERATURE[1]

THAT changes occur in the linear dimensions of metals following fluctuations in the temperature is common knowledge, but that similar changes result in wood and living trees is not so generally known. Pure water has its smallest volume at 4° C., and lowering the temperature further increases its volume until it freezes; while ice contracts regularly with decreasing temperature and at a greater rate than any of the metals. It is generally supposed that marked changes in temperature have some effect upon the volume of tree trunks because radical clefts occur so frequently in severe winters and old clefts close during the middle of warm winter days and open again as the temperature sinks during the night. Since freezing water often bursts its container it is popularly held that such tree trunks are burst by the expansion of the freezing water in them. Caspary[2] has shown this

[1] This review of the literature of branch movements and observations grew out of a study of crown-rot of fruit trees and is published separately because it is only indirectly related to the main theme.

[2] R. Caspary, "Ueber Frostspalten," *Bot. Zeit.*, 13: 449–62, 473–82, 489–500, 1855; "Neue Untersuchungen über Frostspalten," *Bot. Zeit.*, 15: 329–35, 345–50, 361–71, 1857.

to be erroneous by calling attention to the facts that ice contracts as the temperature sinks while clefts in tree trunks open farther and farther as the temperature drops, *i. e.*, were the opening of the clefts due to the formation of ice they would close again as the temperature sank lower. As a matter of fact tree trunks begin contracting above the freezing point of water, as may be gathered from Caspary's records given in the above cited papers on the opening and closing of clefts, as well as from direct measurement of circumferences.[3]

According to the figures in text-books of physics changes in the lengthwise dimension of wood due to a change of temperature are only slight as compared to changes resulting in transverse direction. The transverse contraction of wood is given as nearly the same as the linear contraction of ice. It has been suggested that different types of tree tissues contract at different rates and that the branches of trees are caused to move up and down by changes of temperature owing to a differential contraction and expansion of the tissues on the two sides.

The literature of branch movements of trees is rather meager and not generally known, as may be gathered from an article which appeared in 1904, entitled, "An Undescribed Thermometric Movement of the Branches in Shrubs and Trees,"[4] as well as from some recent correspondence with C. C. Trowbridge who has made a study of the subject but had found only Ganong's paper. The earliest published observations and experiments found on branch movements induced by changes in temperature were by Geleznow.[5] He noted that branches of certain trees sink during cold weather and rise again as it becomes warmer. During a thaw branches of linden, birch, elm, and other epinastic species were cut and fixed in horizontal position by their bases, some with their lower sides uppermost; and the position of the tips was marked. As the temperature became lower the inverted branches moved in a direction opposite to that of the branches in normal position, indicating that the direction of movement depends on the make-up of the branches. It was noted, however, that although pine branches are hyponastic and linden branches epinastic, both bend downward as the temperature sinks, showing that the nature of the eccentricity could not be the cause of these movements.

The relative amounts of water contained in the wood of the lower and upper sides of branches gave no convincing results, although it seemed possible that this might have a causal relation to the movement. It was found that the wood on the upper side of pine branches had a greater water content than that on the lower, while in the case of birch and a number of other trees the wood on the underside contained more water than that on the upper. The water determinations were made once each month throughout the year and are interesting aside from any bearing they may have on branch movements. For instance, the bark on the larch was found to contain more water throughout the year than the wood; the wood often contains less water toward the distal end of branches, while the bark usually contains more.

Caspary also made some very interesting observations the year following the studies by Geleznow,[6] although the work was not published until much later. The positions of the ends of convenient branches of ten species of trees were marked on upright stakes driven in the ground and their locations redetermined about sun-up each day from November 29, 1865, to March 24, 1866. Heavy dew and rain were found to cause a slight depression of branches and snow induced considerable sink-

[3] "Crown-rot of Fruit Trees: Field Studies," N. Y. State Agri. Expt. Sta. Technical Bull., 23: 35–39, 1912.

[4] W. F. Ganong, *Ann. Bot.*, 18: 631–44, 1904.

[5] N. Geleznow, "Recherches sur la quantité et la répartition de l'eau dans la tige des plantes ligneuses," *Melanges Biol. Acad. Imper. Sc. St. Petersb.*, 9: 667–85, 1877.

[6] R. Caspary, "Uber die Veränderungen der Richtung der Äste hölziger Gewächse bewirkt durch niedrige Wärmegrade," Internat. Hort. Exhibit Bot. Congress, London, 3: 98–117, 1886.

ing. It was also noted that after a period of rather strong wind the branches drooped much more than was the case in a calm period having the same temperature. But even such influences failed to prevent the rise of branches on the occurrence of low temperature in case of species which normally raised their branches on the coming of cold weather. It was also found that branches were diverted to the right or left on some trees in proportion to the degree of cold. The branches of linden and those of conifers sank with the temperature, while those of *Pterocarya* and *Acer* rose as the temperature became lower. The branches of *Æsculus, Carpinus, Rhamnus* and *Pavia* rose on slight lowering of the temperature and sank when it became colder. The distal ends of the branches on nearly all of the trees under observation stood higher in spring than they did in the preceding fall. The eccentricity of the wood of branches was thought to have no relation to this movement, but it seemed that it might be due to a differential contraction and expansion of the upper and under sides of branches, and it was held that this difference in contraction must be distributed over the entire length rather than being confined to the crotch regions.

Ganong's[7] observations were more limited. He found that branches move or bend upward or toward the axis as the temperature sinks. He reports that the branches had a greater water content during warmer days of winter than during the colder ones and therefore the thermometric movement. According to the determinations by Geleznow the water content of the wood of *Pinus silvestris* reached a minimum in June and a maximum in October, while bark has its maximum in October and its minimum in April. *Acer platanoides* had a maximum water content in the wood in June and a minimum in October; that is, it was found that the minimum water in the wood does not occur in winter, but since his determinations were made monthly they throw no light on the validity of Ganong's inference that the movements depend on periodic variations in the water content. The most recent contribution to this subject is by C. C. Trowbridge.[8] Although only a summary has appeared as yet it promises to be of interest not only because of its content, but also on account of the fact that it is from the physicist's standpoint. Owing to its brevity this summary as given in the proceedings of the Torrey Botanical Club is quoted here in full:

(1) That branch movements occur in certain trees, due to temperature changes below the freezing point of water, and that in certain other trees no movement whatever has been observed. (2) That the movements amount to as much as 3 or 4 ft. differences in the distance from the ground to the ends of certain curved branches which are in length of the order of 20 ft., these changes occurring through a range of 30 degrees below freezing. (3) That little, if any, movement takes place above freezing point of water, and that the movements begin soon after the temperature remains at this point for several hours. (4) That there is a considerable lag in the movement of the branches behind the temperature changes, although a difference in the rate of change of temperature is followed at once by a difference in the rate of change of the position of the branches. (5) That the movements are practically of equal magnitude in December, January and February, that is, the seasonal change is not a ruling factor in this movement.

According to Geleznow, then, tree branches may move either up or down as the temperature sinks. He found that eccentricity of the wood is not correlated with this movement, but that a difference in the water content of the wood on the upper and under sides of branches seems to be, yet he did not consider that an explanation of the movements but only a suggestive parallel. Caspary found three classes of trees in regard to the manner of branch movements: In one class the branches sink and in another they rise on lowering of the temperature and in the third class the branches rise as the temperature is lowered slightly but sink when it gets still colder. According to him the movements of branches result from a differential contraction of the

[7] *Loc. cit.*

[8] "Branch Movements of Certain Trees in Freezing Temperatures," *Torreya*, 13: 86–87, 1913.

under and upper sides of branches. These two investigators agree as to the main groups of trees in respect to the effect changes of temperature have on the position of their branches. It seems, therefore, that Ganong happened to use trees and shrubs which belonged to only one of these classes. The explanation advanced by Caspary is suggestive because it is based on a differential longitudinal contraction of the wood in branches. Some of his earlier studies[9] have shown that tree trunks undergo transverse contraction in proportion to the degree of cold and that the assumptions to the contrary are incorrect. That longitudinal contraction of wood takes place as the temperature is lowered is upheld by many general observations. Trees are frequently cleft in forks of the trunk during winter and these clefts open when it gets cold and close as warmer weather comes. In another connection the writer found that

> crotch clefts were always at right angles to the branching and usually widest above, appearing as though the crotches had been split by driving in a thin wedge from above. In two instances where measurements were taken the component parts of the crotches had separated about 2 cm., which seems to indicate that there had also been a longitudinal contraction of the outer portions of the trunks, thus resulting in an outward bending of the branches.[10]

Caspary's observations on the lateral displacement of some tree branches also fit into his contraction theory, although he failed to note it, provided it is assumed that the trees on which this movement occurred had trunks with the so-called twisted grain, for in such a case longitudinal contraction would necessarily result in lateral movement of the attached branches.

In this connection it seems of interest to notice some of the peculiarities of arrangement of the tissues about the bases of branches that were studied by Jost.[11] He found that the cambium at the basal angles of branches is not eliminated as the stems and branches grow in diameter, but that its cells and those of the tissues differentiating from the cambium glide between each other and also become shorter. In case of the adaxile side crowding and compression are more marked than on the abaxile side, apparently because the angle is usually much smaller. Sometimes the bark in the adaxile angle is not forced outward, but is included, and under such conditions the pressure in the angle compels the cambium under the included bark to cease growth. Most commonly, however, thé wood-growth in the angle forces the bark outward and thereby induces a more rapid reduction in the cambial area and a greater increase in thickness per annual ring than on the abaxile side. In addition to gliding between each other, the cells in the adaxile side are turned at a tangential angle so that large groups of them come to lie almost horizontal or at right angles to the axis, while groups of cells from the branch and from the stem sides are forced in among these transverse cells of the crotch. Usually, then, no cambial cells are eliminated in branch-angles, but they are forced between their neighbors and complicated tangles result in which often large groups of cells come to lie in a more or less transverse direction. The ends of medullary rays vertical to each other in the base of branches come closer together and may even cross each other.

In view of the fact that the groups of partially transverse tissues at the base of a branch are probably under more or less pressure and because changes of temperature have a much greater effect upon transverse than upon longitudinal dimensions it seems possible that the differential contraction which according to Caspary is the cause of the thermometric branch-movements may be chiefly confined to the bases of branches and depend upon these peculiar gnarly growths described by Jost, and perhaps their arrangement about the base of a branch which is usually characteristic for a species, may determine whether a branch shall move up or down as the temperature sinks. The relative amounts of "spring" and "summer" wood in the under and upper sides

[9] *Loc. cit.*

[10] *Loc. cit.*, pp. 36–37.

[11] L. Jost, "Ueber einige Eigenthümlichkeiten des Cambiums der Bäume," *Bot. Zeit.*, 59: 1–24, 1901.

of annual rings at the bases of branches may also have a possible relation to the movements. At any rate, it seems more promising to seek for some anatomical differences between the upper and under sides of branches as the cause of the movement than to study their water content.

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SPECIAL ARTICLES

"YELLOW" AND "AGOUTI" FACTORS IN MICE

SOME time ago Mr. A. H. Sturtevant[1] suggested the hypothesis that there is negative coupling between the "yellow" and the "agouti" factors in mice. At that time[2] I offered certain facts which appeared to me to give evidence contradictory to the hypothesis which he advanced.

I included in this evidence the data offered by certain matings of mice made by Miss F. M. Durham.[3] It now appears that I misunderstood the true meaning of her tables, which were somewhat ambiguous, and that accordingly the only remaining evidence which I possessed against Mr. Sturtevant's hypothesis was afforded by the results of certain matings which I made about five years ago.

It seemed, therefore, advisable to make crosses calculated to test his hypothesis with the stock which I have at present on hand.

The first of these matings was between wild agouti mice and yellow mice which did not carry the agouti factor. To use Sturtevant's terminology these individuals were as follows:

Yellows—*Yt yt*,
Agouti—*yT yT*.

Two sorts of individuals, yellow and agouti, are expected in equal numbers from such matings. The actual results were 14 yellow, 28 agouti. The yellows should on Sturtevant's hypothesis be of the formula *Yt yT* and form only two sorts of gametes *Yt* and *yT*. Such yellows should by any non-yellow animal, or when mated *inter se,* give only two sorts of young, yellow and agouti. Actually they produced 23 yellow and 18 agouti young.

Thinking that possibly the *black* factor might be necessary to obtain such a result, I mated three homozygous dilute brown agouti animals with a single brown-eyed yellow (carrying no agouti). All these animals lack the factor for black. The first generation gave 11 yellows and 5 brown-agoutis. The yellows were then crossed with dilute *brown* animals which did not possess the factor for agouti. If according to Sturtevant's hypothesis there was negative coupling or repulsion between the yellow and agouti factors there would be only yellow and agouti young from such a mating. If, on the other hand, these factors were entirely independent we should have non-agouti young as well. The results follow.

	Yellow	Dilute Yellow	Brown Agouti	Dilute Brown Agouti	Brown	Dilute Brown
Observed	31	34	24	27	0	0
Expected by Sturtevant's hypothesis	29	29	29	29	0	0
Expected by independent recombination	28.5	28.5	14.2	14.2	14.2	14.2

The conclusion is obvious that the factors for yellow and agouti are unable to go into the same gamete. On the other hand, the factors for "density" and "dilution" of pigmentation show no such relation to any other factors.

Since I have no reason to doubt the authenticity of the contradictory cases, in my own work, to which I have already referred, it seems probable that the factors for "yellow" and "agouti" are not absolutely incompatible, but that they may in rare cases occur in the same gamete. As a general thing, however, it seems that Sturtevant's hypothesis is correct and that a negative association exists between these two factors.

C. C. LITTLE
BUSSEY INSTITUTION,
FOREST HILLS, MASS.,
July 7, 1913

[1] Sturtevant, A. H. (1912), *Am. Nat.,* Vol. 46, pp. 368–371.

[2] Little, C. C. (1912), *Am. Nat.,* Vol. 46, pp. 491–493.

[3] Durham, F. M. (1911), *Journal of Genetics,* Vol. 1, pp. 159–178.

ANTIGRAVITATIONAL GRADATION

Nowhere on the face of our globe, we now know, are the effects of the gradational processes so completely or so conspicuously exemplified as on the broad intermont valleys of arid regions. There the graded plain is the dominant feature of landscape. It attains a degree of perfection that is wholly unknown elsewhere. It is more even than is theoretically demanded of the ideal or finished peneplain. It is, as Passarge astutely remarks, smoother than any peneplain possibly can be. Yet never has relief element been so generally misunderstood or so entirely overlooked.

In the course of the wide discussion which the subject recently has aroused in almost every land it is fortunate that so many localized illustrations have been so carefully described. For the first time we are now able to cite definite references. The present aspect of the theme centers around the topic of local dissection and terracing of the steeper slopes immediately encircling many desert mountain ranges—the belt designated by physiographers as the *bajada,* the title being an adapted Spanish name.

The remarkable phenomenon of bajada-terracing does not appear, as urged by Salisbury, to be a necessary consequence of the general lowering of the highland by stream-action while the intermont lowlands are being filled up, because some of the best examples of terracing border broad plains having rock-floors. For the same reason it does not appear possible that there ever occurs during so-called topographic maturity an adjustment by water-action between one bolson and another adjacent but lower one which results in the terracing of the higher, as suggested by Davis. There is little or no evidence to show that bajadas were all formed during periods of glaciation, as advocated by Barrell, since some of the most typical forms of this class are found surrounding low knolls near sea-level and far below all possible altitudes of glacial action in the region. Neither does it seem likely that bajadas were constructed during interglacial epochs of materials which accumulated in the mountains when the latter were covered by ice, as argued by Huntington, for this does not explain the many bajada-belts with rock-floors. Nor is it any better to postulate a recent increase of temperature and a different distribution and amount of rainfall abetted by the advancement of the area in the geographic cycle, as proposed by Visher, for the terracing is now going on before our very eyes at an astonishingly rapid rate, and as quickly is it also completely obliterated.

Terracing of desert tracts appears to be confined mainly to the foots of the loftier ranges; and its accomplishment is fully described elsewhere. Under the ordinary conditions of deflative action we would expect the locus of maximum lowering to take place in the middle part of the bolsons. According to this recognition of conditions eolic erosion necessarily operates from the lower to a higher elevation. As shown by Professor Davis, the winds in their action are not dependent like water on the gradient of the land surface for their gravitational acceleration; they may blow violently and work effectively on a perfectly level surface. Unlike water they may also erode vigorously up-hill; and this is exactly what they manifestly and constantly do on the bolson-plains.

Notwithstanding the fact that wind erosion operates both up and down the slope there is, owing to the peculiar configuration of each basin-shaped tract, a preponderance of effect on the up-slope part of the course. There also appears to be a limit to the gradient on which the wind is able to blow sands erodingly and extensively up-hill, and this limit seems to lie chiefly between a two and a four per cent. gradient. It is for this reason seemingly that the intermont plains are so smooth, so uniform in grade, so high in gradient. Eolic gradation thus mainly works from a lower to a higher level. The direction of greatest activity is directly opposite that of stream-work. It is mainly up-hill.

Charles Keyes

SCIENCE

FRIDAY, AUGUST 15, 1913

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

PROFESSOR THOMAS HARRISON MONTGOMERY, JR.

THOMAS HARRISON MONTGOMERY, JR., was born in New York City March 5, 1873, and died in Philadelphia March 19, 1912. Within this brief span of years he accomplished much; by the strength and manliness of his character he exerted a deep influence on all who knew him, by the extent and value of his scientific work he has left a lasting impress on his chosen science of zoology. This biographical sketch has been prepared as a tribute to the memory of a friend and colleague and in the hope that a more intimate acquaintance with his life and work may be welcomed by all who knew him either in person or through his writings.

In inheritance and education Professor Montgomery was unusually favored; he came of a distinguished family and his environment and training were of the best. The Montgomery family came to America from Ayrshire and settled in New Jersey in 1701. Among the paternal ancestors of Professor Montgomery were many distinguished clergymen, lawyers and business men. One of his great-great-grandfathers was William White, "the first bishop of English consecration in the United States." Through his mother, Anna Morton, he was descended from a line of distinguished physicians and scientists; his grandfather, Dr. Samuel George Morton, was one of the founders of the modern science of anthropology and was president of the Academy of Natural Sciences of Philadelphia from 1849 to 1851. Professor Montgomery sometimes spoke of Dr. Morton in a way which indicated that he had been deeply

influenced by the example of his life and work.

His father, Thomas Harrison Montgomery, was president of the Insurance Company of North America from 1882 until his death in 1905. He was a gentleman of unusual culture and ability, deeply interested in the work of churches, charitable organizations and educational institutions, and the author of several publications on genealogical and historical subjects, among which the most notable was a book of nearly six hundred pages entitled "A History of the University of Pennsylvania from its Foundation to A.D. 1770." In recognition of his scholarly ability the University of Pennsylvania conferred upon him the honorary degree of Litt.D. He had a large family, six sons and three daughters, and his influence over his children and their admiration for him deeply impressed all who came into their family circle. Professor Montgomery summed up his "Memoir" of his father in these words:

> One can paint certain traits of this large and rich character, but it is difficult to make a just portrait. A man of virile and broad mind, of very catholic tastes; a respecter of knowledge and a contributor to it; true and generous to all; with unimpeached personal honor; self-deprecatory but always compelling respect; ever active in work and economical of time, striving to do his best; a wise and tender husband and father, and a noble Christian gentleman. A man of religion that has no harshness but is filled with sweetness and hope and charity.

In his education and environment Montgomery was no less favored than in his inheritance. When he was nine years old his father removed to the country near West Chester, Pa., and here his real education began in the fields and woods about his country home. It was particularly in the study of birds that the mind of this naturalist was formed and moulded. Not later than his twelfth year he began to make a systematic study of the birds found in the vicinity of his home and by the time he was fifteen he had a collection of about 250 bird skins, and a record of each specimen giving the date and locality, food, measurements, and, under "remarks," many observations on anatomical and ecological features. By the time he was seventeen his collection had grown to about 450 bird skins, and his observations entered in his notebooks form many pages, perhaps volumes,[1] of interesting and discriminating observations on the migrations, habitats, breeding and nesting habits, food and methods of getting it, care of young, songs and notes, and many other details of the life of birds. Other notebooks contain detailed drawings of dissections, skeletons and general anatomical features. Intermingled with these observations on birds are many expressions of delight in the beauties of nature, in the splendor of the woods in winter, the joys of an early summer morning, the majesty of a thunderstorm, etc.

His formal schooling began at Dr. Worrall's School in West Chester; afterwards he attended the Episcopal Academy in Philadelphia, where he graduated at the age of sixteen. In the fall of 1889 he entered the University of Pennsylvania and continued there until the end of his sophomore year. While at the university his only biological work was a course of lectures by Cope on recent and fossil vertebrates which gave him a deep and lasting interest in comparative anatomy and paleontology. Supplementary to his work at the University he spent much time at the Academy of Natural Sciences of Philadelphia, studying in the museums and library, and there he developed that omnivorous

[1] The earliest notebook I have seen is headed "Note Book No. 5," and dates from his seventeenth year.

taste for all kinds of zoological literature which was one of his strong characteristics. He once said to the writer that while he was at Berlin he read the whole series of the Naples *Jahresberichte*, and as his memory was unusually retentive he soon acquired a very broad acquaintance with the literature of his science.

In the summer of 1891 he accompanied his father on a trip to Europe, and, fascinated by the possibilities for the study of anatomy and zoology in Germany, he persuaded his father to allow him to stay there for the remainder of his university course. He entered the University of Berlin in the autumn of that year, devoting attention particularly to human anatomy and morphological zoology. He applied himself with great energy and enthusiasm to his work and matured very rapidly as a student and investigator. It had been his intention to go to Leipzig for a portion of his university course, but his work in Berlin kept him so busy and so satisfied that he remained there for three years, taking the degree of Ph.D. in 1894, when he was but twenty-one years old. His preceptors in Berlin were Waldeyer, O. Hertwig, F. E. Schulze, Schwendener, Möbius, Dames, Heider, Korschelt and Jaeckel. He prepared his thesis under the direction chiefly of Schulze. Student associates at Berlin whom he often mentioned and who left a deep impress upon him were Fritz Schaudinn, afterward famous for his study of pathogenic protozoa, and F. Purcell, at present director of the Capetown Museum, South Africa.

As indicative of the strong hold which studies of evolution had made upon him may be mentioned the three theses which he defended on the occasion of taking his degree: "I. Für die Phylogenie ist das Studium des Nervensystemes von der grössten Wichtigkeit." "II. Die Nächsten jetzt lebenden Verwandten des *Limulus* sind die Arachnoiden." "III. Vogelarten, die periodisch lange Wanderungen durchmachen, haben keine geographischen Varietäten."

Whereas his earlier studies had been devoted largely to birds, his work at Berlin was chiefly on other classes of animals. His inaugural dissertation was an anatomical and histological description of a new genus and species of nemertean worm found at Berlin, and this was the first of a series of ten papers which he wrote on this group of animals. However, his interest in ornithology did not flag, and in several letters to Witmer Stone he expresses his great interest in the work of the American Ornithological Union, of which he had been elected a member, and his regret that he was unable because of the pressure of other work to continue his study of birds while abroad. Just before he took his degree he wrote to Mr. Stone:

> I have done absolutely no ornithological work in Germany, and will probably never have the time for it in the future. I have been studying especially comparative anatomy and embryology, but I have not yet lost my little taste for collecting and general field work, though that is now for me simply a happy bygone.

Nevertheless, after his return from Germany he continued for some time to record his observations on birds in his "Ornithological Field Notes," and he later published five papers based largely on these observations; up to the time of his death his interest in birds and in general field work never waned.

He returned to this country early in 1895 and for the next three years occupied a research room at the Wistar Institute of Anatomy in Philadelphia, where he continued to work unremittingly at his researches. During the summer of 1895 he studied in the laboratory of Alexander Agassiz at Newport and at the U. S. Fish

Commission Station at Woods Hole. In the summer of 1896 he worked for a while at the marine laboratory of the University of Pennsylvania at Sea Isle City, N. J. The summer of 1897 he spent at the Marine Biological Laboratory, Woods Hole, and thereafter nearly every summer of his life was spent there, except for four summers, when he was in Texas.

In 1897 he was appointed lecturer in zoology at the University of Pennsylvania; in 1898 he was advanced to an instructorship and in 1900 to an assistant professorship. During the years 1898 to 1903 he was also professor of biology and director of the museum in the Wagner Free Institute of Science in Philadelphia. In 1903 he was called to the professorship of zoology in the University of Texas, where he remained until 1908, when he became professor of zoology and head of that department at the University of Pennsylvania, and in this position he continued until his death in 1912.

He was a trustee of the Marine Biological Laboratory and clerk of the corporation of that institution from 1908 until his death, and during the same period he was co-editor of the *Journal of Morphology*. He was a member of the American Association for the Advancement of Science, the American Society of Naturalists, the American Society of Zoologists, of which he was president in 1910, the American Philosophical Society, the Academy of Natural Sciences of Philadelphia and the Texas Academy of Sciences, of which he was president in 1905.

This bare catalogue of the positions of responsibility and honor which he held indicates how rapidly he rose to prominence in his science, but it does not indicate the means by which he achieved distinction. It remains to describe his unusual qualities as an investigator, as a teacher and organizer, and as a man.

He was an unusually active investigator in many fields, and a ready and prolific writer. His life as an author extended only from 1894 to 1912, eighteen years in all, but in that time he made many valuable contributions to science and published one large book and more than eighty papers. His breadth of view and of sympathy is indicated by the numerous branches of zoology to which he contributed. Sixteen of his papers were devoted primarily to taxonomy, five to distribution, eleven to ecology and behavior, sixteen to morphology, twenty-five to cytology, eight to phylogeny and one to experiment. He had just begun on experimental work during his last year, and there is no doubt that he would have contributed largely to this branch of zoology had he lived. His breadth of view is shown also if one considers the groups of animals studied. His earliest publications dealt with nemertean worms, on which he wrote ten papers; his observations on birds are given in five papers, and those on other vertebrates in two; he published ten papers on hair-worms, two on rotifers, fourteen on spiders, three on insects, twenty-five on cytology, of which fifteen dealt with insects alone, and sixteen on phylogeny and general topics (see bibliography).

Most of this work was very good and some of it was remarkable for its influence. Among his most important contributions must be mentioned particularly his various papers on the habits of spiders (Nos. 31, 37, 38, 41, 42); his studies on the nucleolus (Nos. 47, 48, 50); and his extensive studies on spermatogenesis (Nos. 49, 51–71). In the latter field a discovery of really epoch-making importance was his observation of the conjugation of separate chromosomes in preparation for the maturation divisions, and his clearly reasoned conclusion that one chromosome of each pair is of paternal and the other of maternal origin.

Another discovery of the utmost importance was that in certain Hemiptera an odd number of chromosomes may be present in the divisions of the spermatocytes, but he just missed the discovery that this phenomenon is associated with the determination of sex, though after this discovery was made by McClung, Stevens and Wilson, his later work did much to confirm it. His discrimination of the different kinds of chromosomes and his terminology for these (62) has been widely accepted and now forms part of the science of cytology. His studies on nucleoli, particularly his great work on the morphology of the nucleolus (48), contain a wealth of observations on these structures in a great number of animals, and this work did much to establish the conclusion that the nucleolus is a relatively unimportant part of the nucleus. When he had reached this conclusion he turned his attention at once, and with characteristic directness, to those parts of the cell which he considered most important, viz., the chromosomes.

It was in studies of natural history and general zoology that he took greatest delight and his work in these lines was particularly valuable. His early training gave him a fondness for, and facility in, taxonomic and faunistic work. He described many new species of nemerteans, hairworms, rotifers and spiders; he made faunistic lists of these animals as well as of birds and certain insects; he loved museum work and had the systematist's veneration for "type specimens." But his taxonomic work was much more than a bare description of species; it usually involved a thorough study of the anatomy and histology of the forms described, and to this he added, whenever possible, a study of their life histories and habits. He maintained that taxonomy of the right sort was one of the most inclusive and fundamental branches of zoology, since it involved practically all other branches of the science.

His studies on the behavior of animals are especially important. With great patience and enthusiasm he would spend days and nights studying the habits of different animals. His observations on the feeding habits of owls (13) are a model of their kind, and his studies of the habits of spiders (31, 37, 38, 41, 42) are worthy of the great masters of natural history, whose best works they recall.

He was a naturalist before he was a laboratory scientist, and he looked forward to the time when he could direct all his researches to the study of spiders as Wheeler had done for ants. The character and methods of his work were his own and in many instances can be traced back to his early training as a naturalist. He allowed no one to bring him "material" for study; indeed, the animals he studied were never mere "material" to him, but he did his own collecting. To all his friends the many newly turned stones in the fields about Woods Hole were a sign that Montgomery had been collecting there.

Although he held tenaciously to the value of the old zoology, he was quick to grasp the importance of work in new fields and bold and independent in entering them and in reaping their harvests. This applies especially to his work in cytology, for which he had made no special preparation, but in which he probably achieved his greatest successes. He clearly distinguished large problems from small ones, and he went straight to the center of each. He was keen in seeing the theoretical significance of his observations, and critical but just in estimating the value of the work of others. He was peculiarly independent in his work and was not in the habit of discussing it with others nor of asking advice, and it often happened that

even his intimate friends did not know his conclusions on important matters until after they had appeared in print.

He was primarily a naturalist and had no patience with experimental work done by men who had no intimate acquaintance with the animals studied; he characterized such experimentalists as "Versuchstiere," and hated their so-called "problems." Later he came to be an enthusiastic advocate of the experimental method as a supplement to, but not as a substitute for, observational studies, and in his new laboratory he had made extensive provision for such work.

He was a very rapid worker, and as he wrote up his results at once and published them without delay he always had several papers in press, and at his death it was found that he had left but little work unfinished. One notable exception is a textbook of cytology for which he had completed eleven chapters, leaving the rest of it in outline. It is to be hoped that this valuable work will be completed and published. In it he manifests that unusual mastery of the literature of the subject which was one of his leading characteristics, and which particularly fitted him for such a task.

As a teacher and organizer he was successful in a rare degree. His enthusiasm was balanced by critical judgment, and he was an inspiring and exacting teacher. His intimate acquaintance with the materials and literature of zoology, his positive and clear-cut opinions on most subjects, a sense of humor and a certain picturesqueness of language made him a most instructive and entertaining lecturer; also he had marked ability to direct and stimulate graduate students in research work. His plans for the development of zoology at the University of Pennsylvania were very comprehensive, including almost every great branch of the science.

During the last three or four years of his life, his greatest work was the new zoological laboratory at the University of Pennsylvania, which will ever be a monument to his energy, ability and foresight. He and his colleagues worked on the plans almost a year, and all details of construction, equipment and furniture were carefully planned. Almost another year was spent in constructing the building, and the labor of moving into it and getting things into working order had scarcely been finished when he was stricken with his last illness. He deeply regretted the loss of time from his researches which the construction of the building involved, but as the plans and building were completed rapidly, this lost time was reduced to a minimum, and he expected to enjoy for many years the facilities which he had so laboriously secured.

Although he often spoke of the time lost from his researches while the building was on hand, it is nevertheless a fact that during those years he published almost as many papers as during any previous period of equal length, while the number of papers published during the last year of his life was as great as in any other year, with a single exception. He realized that the new laboratory must be justified by the research work done in it, and the responsibility of "making good" rested heavily upon him. Undoubtedly during those last few years he worked beyond his strength, and when the fatal disease attacked him he had not resistance enough to overcome it.

He was stricken with pneumonia on February 15, 1912, and after a long struggle, in which hope many times alternated with despair, he succumbed on March 19, only a few days after his thirty-ninth birthday. His death, which occurred on the opening day of the celebration of the centenary of the Academy of Natural Sci-

ences of Philadelphia, cast a shadow over that event. From boyhood days his interest in the Academy had been keen and he had taken an active part in the preparations for the centennial celebration and had contributed an important paper on "Human Spermatogenesis" for the commemoration volume of the *Journal* of the Academy; this paper, which was his last contribution to science, appeared as the first article in the commemoration volume, which was issued some time after his death. His funeral was attended by many people from a distance, who had been present at the Academy's Centennial, as well as by his colleagues and students. His body was borne by his family and a few intimate friends to its last resting place on a hill overlooking the beautiful Schuylkill Valley and the great city with which his life had been so intimately identified.

His influence on science has reached many who never knew him and will last long after his personality is forgotten, and yet it is as the person, the man of honor and fidelity, of high ideals and courage and courtesy, that his friends love to remember him.

In person he was unusually tall and slender, with a serious but kindly face, and his general appearance gave the impression of great vigor of mind and will rather than of body. He was, however, capable of great physical endurance and was rarely ill. He matured early and appeared older than he really was and this appearance was strengthened by the way in which he regarded himself.

In 1901 he married Priscilla, daughter of John and Elizabeth Braislin, of Crosswicks, N. J. To them were born three sons, Thomas, Hugh and Raymond, and the pleasure which he took in the society of his wife and boys, and his devotion to them, demonstrated that he was a man of affection as well as of intellect, a loving husband and father as well as a distinguished scientist.

In his ornithological notebooks he has revealed his heart as in no other of his writings. Intermingled with the observations which he records are many passages evidently intended only for his own eye, and it seems almost like intruding into private matters to make them public, and yet they reveal so fully his inner motives and the philosophy of his life that it seems to the writer that the sketch which has here been drawn would be sadly incomplete without some reference to them. Under date of September 22, 1898, he gives a list of the summer birds still to be seen near his country home, and then after some comments on the beauties of the changing seasons, writes some ten pages on what might very properly be called the religion of a naturalist. Unfortunately limits of space do not permit the publication in full of this passage, but the following extracts are taken from it:

> In the make-up of the naturalist belongs as much appreciative interest as keen perceptive ability. In a word the naturalist must feel himself at one with nature. . . . The faintly heard note of a bird, the first odor of spring in the air, the moaning of wind in the spruces, or the wondrous insect humming on an August night—these are what set a train of vague but deliciously keen memories and longings in motion—a mental state which is the purest and most spiritual. Whoever has a true and tender love for the natural may experience at least the unexplained joy produced by such yearnings. . . . Such yearnings are the sublime in the experience of the naturalist. . . .
>
> To me there are memories more precious than all others, memories of elated mental states associated with enthusiastic appreciation of the natural. . . . Analysis of such states may be possible, but shall one tear apart the web of his best dreams? . . .
>
> What is the basis of such longings? Many would regard them as trivial or foolish, but the many are not naturalists. I recall with startling vividness when as a small boy I first heard the cat-bird's song in Central Park, New York City;

that was the first song that ever stirred me, but it left a yearning ineradicable as long as the mind lasts. Another time on the top of a small oak tree, on a bitterly cold winter day, I saw a pine finch, the only morsel of living nature in sight; the peculiar happiness of that moment will never be forgotten. The mating note of the red-winged blackbird, when it first arrives in the spring, or the tremulous note of the white-throated sparrow; at twilight the rich variety of notes of the screech owl; cold nights on the coast of Maine with the plover lined along the shore; or titmice in the pine forests of Germany;—such associations and innumerable others, appear to the memory time and time again, . . . and they are always an unexplained joy.

Perhaps such associations are hallowed merely in comparison with the tedium of life's little cares. This is very probably the case, but it in no wise lessens the joy. Man must work, he is paid by the work rather than by the hire, and his enjoyment is found in his work. But far above the plane of such enjoyment is the wonderful ecstasy produced by yearnings whose object is unknown. In human nature the wonderful thing is the multiplicity of characters, and the infinite number of changes and moods in each character. One of these is the character of the poet and naturalist. A naturalist may not be "born" one, for this is a loose expression. But he must become one in his earliest, purest and most impressionable years; let a few years go by, and the clay is too hard for the mould. Once a naturalist always a naturalist, the zeal of a naturalist never dies, but he must not be fettered in his pursuits. The cravings of which we have spoken are the poetic, spiritual side of the naturalist—the naturalist in contradiction to the *Naturforscher*. . . . One may become an excellent morphologist or physiologist, a clear elucidator of phenomena, and yet be without any poetic spirit. Or one may derive his most hallowed impressions from presentations in the laboratory, while another gets them from observation of objects in the field. One can only postulate that for certain natures vague naturalistic sensations are productive of the greatest joy. I too can testify to the keen joy experienced when after months of toil and many failures one attains the solution of a difficult problem. But in my case such a joy does not make as lasting an impression as does the pleasure from the mental states spoken of above; and surely the strength of a joy may be measured by the length of its duration.

He loved to spend many hours alone in fields and woods observing living creatures and feeling himself to be "a modest but integral part of nature" and yet he was not a mystic nor a recluse, but a jovial and delightful comrade who took great pleasure in association with intimate friends. He had a fund of dry humor with which he lightened up serious subjects of conversation and yet on such occasions he never let himself go beyond proper and dignified bounds. He was a firm friend and a good hater—a man who was reserved and strenuous, but tender and sympathetic; and above all one whose chief motive in life was an absolute devotion to truth. His great will power was one of his most striking characteristics. His ability to concentrate all his energies upon his work was remarkable; at such times nothing diverted him and he allowed himself no relaxation. His powers of self-control in all personal relations were equally remarkable; although his nature was intense he was always master of himself. He was a strong and virile man—and yet he was not domineering nor self-willed and he preserved an exquisite balance between self-contained dignity and charming courtesy toward others. He was always kind and sympathetic, and it was from real kindliness of nature, as well as from good breeding that those qualities arose which to many of his friends seemed to entitle him in a peculiar degree to "the grand old name of gentleman."

He was for a few years consciously and joyously a part of that nature which he so much loved. He has left to men the record of a life devoted to science and enlightenment, and to his family and friends the memory of a true and noble soul.

EDWIN G. CONKLIN

FORECAST OF THE BIRMINGHAM MEETING OF THE BRITISH ASSOCIATION[1]

THE meeting of the British Association for the Advancement of Science, which will

[1] From the London *Times*.

open in Birmingham on September 10, will be the fifth meeting which the association has held in the metropolis of the Midlands. The first Birmingham meeting was as far back as 1839, nine years after the association was established; the Rev. W. Vernon Harcourt, F.R.S., was president, and the attendance numbered 1,438. At the second Birmingham meeting, ten years later, when the Rev. Dr. T. R. Robinson, F.R.S., was president, the attendance sank to 1,071, one of the smallest musters in the history of the association; but at the third meeting, in 1865, when Professor J. Phillips, F.R.S., was president, the attendances totalled 1,997. The last meeting held in Birmingham was in 1886, two years after the association had paid the first of its visits to the overseas empire at the invitation of the city of Montreal. As an acknowledgment of the hospitality then shown to the association, as well as of the high standard of scientific attainment in Canada, the president of the Birmingham meeting in 1886 was Sir J. William Dawson, F.R.S., principal and vice-chancellor of McGill University. Both in point of numbers and as regards the scientific interest of the proceedings, the meeting was one of the most successful in the long record of the association. The attendance numbered 2,453, and among the sectional presidents were Professor (afterwards Sir) George Darwin, F.R.S., Mr. (afterwards Sir) W. Crookes, F.R.S., Professor T. G. Bonney, F.R.S., and Major-General Sir F. J. Goldsmid.

Hopes are entertained that the forthcoming meeting will be the largest of all the Birmingham meetings. There are expectations of an attendance of over 3,000, and the program of the meeting, both on its scientific and social sides, is certainly one of a very attractive order. Appropriately enough, Sir Oliver Lodge will assume the presidential chair at the inaugural meeting. By conservative men of science the principal of Birmingham University is regarded as decidedly heterodox in some of his views; but he has the courage of his convictions, and is not afraid, when grappling with problems of supreme human interest, to take a wide view of the scope of scientific research. How far he will allow himself to go in this direction in his presidential address is not known, but the subject of it, so far as yet defined, offers numerous possibilities, and the address is certain to be awaited with a good deal of curiosity. At present Sir Oliver Lodge's idea is to take a wide and philosophical survey of the position of science in general, incidentally dealing with the discussions and controversies relating to the existence and the functions of the ether of space, and to the physical continuity of which it is the chief element.

ACCOMMODATION AND ENTERTAINMENTS

Birmingham is excellently fitted to accommodate the largest congresses, even when they attain the size and complexity of the British Parliament of Science. The twelve sections composing the association will be much less scattered than in many cities in which meetings have been held. No fewer than seven of the sections will be grouped in one of the university buildings, Mason College. Excellent quarters have been found for the other sections in Queen's College, the Midland Institute, the Technical School and the Temperance Hall. The Town Hall has been allotted for the use of the association as a general reception room, and in the new Art Gallery of the Council House the Lord Mayor will hold a reception on the evening of Thursday, September 11. On the afternoon of the same day the university will confer honorary degrees on some of the most distinguished visitors, the ceremony taking

place in the new university buildings. Besides British men of science a considerable number of foreign men of science are expected to be present, among others who have accepted invitations being Professor Svante Arrhenius, of Stockholm, M. Lallemand, Professor Keibel, Professor Reinke and Professor Pringsheim. As usual, there will be various garden parties and other social functions for the entertainment of the visitors, as well as excursions on the Saturday to places within easy reach of Birmingham, including Stratford-on-Avon, Kenilworth, Worcester, Malvern and the Forest of Arden. A novel feature has been introduced into the program of entertainments in the shape of special performances at the Prince of Wales's Theater (opera), the Repertory Theater (modern drama) and the Kinemacolor Theater.

These festivities, of course, will be merely incidental to the serious work of the meeting, a permanent and valuable memento of which will be the handbook to the Birmingham district which is being prepared under the editorship of Dr. Auden. Mr. Neville Chamberlain is contributing to this handbook a section on town-planning, and a new and ingenious series of maps is being prepared for it under the direction of Professor Lapworth, F.R.S. Two evening discourses will be delivered on Friday, September 12, and Tuesday, September 16, the lecturer on the first occasion being Sir Henry H. Cunynghame, K.C.B., who will take for his subject "Explosions in Mines and the Means of preventing them"; while the lecturer on the second occasion will be Dr. A. Smith Woodward, F.R.S., who will treat of "Missing Links among Extinct Animals." Five lectures have been arranged by the council at the Digbeth Institute for citizens who are not members of the association. The first of these, "The Decorative Art of Savages," will be given by Dr. A. C. Haddon, F.R.S., on Thursday, September 11, at 8 P.M. Other lectures will be "The Panama Canal," by Dr. Vaughan Cornish; "Heredity in Relation to Man," by Dr. Leonard Doncaster; "The Microscopic Structure of Metals," by Dr. W. Rosenhain, and "Radio-activity," by Dr. F. Soddy, F.R.S. For the following particulars of the sectional proceedings we are indebted to the sectional presidents and recorders.

THE WORK OF THE SECTIONS

Section A (Mathematical and Physical Science) will have for its president Dr. H. F. Baker, F.R.S. He will probably speak of the relations of pure mathematics to the ordinary activities of life, trying to indicate what seem to him the justifications of a serious study of the subject, and thence proceeding to an attempt to set before those who have some mathematical knowledge an idea of the extent and present promise of the subject, by referring to some of the leading problems and their interconnection. During the week of the meeting the section will engage in several important discussions. Professor A. E. H. Love, Professor E. Rutherford and Professor Pringsheim have promised contributions to a discussion on radiation; mathematical geography will be the subject of a joint discussion with the geographical section; the investigation of complex stress distribution will be discussed with the engineering section; and there will also be a discussion on non-Euclidean geometry. Among individual papers one on lightning and protection from it will be presented by Sir J. Larmor, another on atmospheric pollution has been promised by Dr. J. S. Owens, while the dynamics of evolution will be discussed by Mr. A. J. Lotka.

The president of Section B (Chemistry)

will be Professor W. Palmer Wynne, F.R.S. His address will deal mainly with some problems and aspects of organic chemistry. A subject of national importance which will be discussed by the section is the economical use of coal and fuels derived therefrom. Among others who are expected to take part in the discussion are Professor Armstrong, Dr. Beilby, Professor Bone, Dr. Wheeler, Dr. M. G. Christie, Dr. Colman, Mr. J. H. Yates, Mr. J. Bond and Mr. R. Threlfall. The discussion will cover gas producers and the use of gas, coking and by-product recovery from small coal, gas fires and their efficiency. Other discussions have been arranged on radio-active elements and a periodic law, to be opened by Professor F. Soddy, and the significance of optical properties. Several metallurgical papers will be presented to the section, including one by Professor E. Cohen, of Utrecht, on strain diseases in metals.

Professor Edmund J. Garwood will preside over Section C (Geology), and in his address will probably touch on the conditions under which certain sedimentary rocks were deposited, especially those laid down during lower carboniferous times. A large number of papers have been promised for the section, among them one by Mr. V. C. Illing on recent discoveries in the Stockingford Shales, near Nuneaton, and another by Mr. F. G. Meacham on the probable development of the South Staffordshire coalfields to the west of the Western Boundary Fault and to the Shropshire Fault and the Severn Valley Fault, with some notes on the probable conditions of mining in the new area. The district round Birmingham offers exceptionally good opportunities for geological excursions, and these will be made the great feature of the sectional proceedings. While the mornings will be given up to the reading of papers, the afternoons will be given up to short excursions, and at the close of the meeting there will be a three-days' excursion into Shropshire. The organization of these excursions is in the hands of perhaps the greatest authority on all this country, Professor Charles Lapworth, F.R.S. As an introduction to the excursions Professor Lapworth will address the section on the geology of the country round Birmingham immediately after Professor Garwood's presidential address.

Section D (Zoology) will be presided over by Dr. H. F. Gadow, F.R.S., who, in addition to his presidential address, will open a discussion on convergence in the mammalia. A subject of vital importance to the development of tropical Africa will be dealt with by Professor E. A. Minchin in a lecture on some aspects of the sleeping sickness problem. Among the papers promised are one by Dr. F. A. Dixey on the geographical relations of mimicry, and another by Mr. W. Bowater on heredity of melanism in lepidoptera. A discussion on mimicry will be opened by Professor E. B. Poulton. During the week a visit will be paid to the Burbage Experimental Station, by invitation of Major Hurst, to view the results of inheritance experiments. An important discussion, which will be held jointly with the physiological and botanical sections, will be opened by Professor B. Moore, F.R.S., on the subject of the synthesis of organic matter by inorganic colloids in the presence of sunlight, considered in relation to the origin of life.

GEOGRAPHY AND SOCIAL QUESTIONS

The professor of geography in University College, Reading, Dr. H. N. Dickson, will preside over Section E (Geography). His address will concern itself with the increasing recognition of the importance of human geography in the study of social and economic questions. Besides the joint

discussion with Section A on mathematical geography, there will be a discussion on the natural regions of the world, to be opened by Professor A. J. Herbertson, of Oxford University. In connection with the former subject the work of the Ordnance Survey, which has lately been submitted to some severe tests, will come under consideration, and a paper of special interest will be one by Captain H. Winterbotham on the accuracy of the principal triangulation of Great Britain. Most of the papers at present promised relate to questions of home geography, but Professor J. W. Gregory will deliver a lecture on Australia and Mr. I. N. Dracopoli will give an account of his recent travels in Jubaland, British East Africa.

The Rev. P. H. Wicksteed, M.A., who will preside over Section F (Economic Science and Statistics), intends to deal in his address with the simplifications in the teaching of political economy which appear to him to follow naturally from the acceptance of the Jevonian, or marginal, theory of distribution, and a frank abandonment of the cost-of-production theory of value. He will point out the confusion which has arisen from the ambiguous use of the term "marginal"—sometimes to signify the least favorable conditions under which an industry is pursued or the least efficient individual who pursues it, and sometimes to signify the dependence of the exchange value of any one of a group of indistinguishable individuals upon the contraction or expansion of their number. An attempt will be made to show that many of the categories and distinctions which still hold a prominent place in the text-books—such as the special laws of rent, interest, and wages, the treatment of buyers and sellers as opposed groups, the conception of increasing and diminishing returns as rival principles that divide the field of industry between them—should either be abandoned or reduced to a secondary position. No attempt will be made to introduce any new principles, or to defend the "marginal" theory against actual or possible attack; Mr. Wicksteed will simply endeavor to develop the modifications in the methods of teaching and systematic exposition which, in his opinion, follow upon adoption of the theory.

The chief subjects which will come under consideration in the subsequent proceedings of the section are the cost of living, inland waterways, and trade unions in relation to profit-sharing and co-partnership. The discussion on the second of these subjects promises to be specially interesting. Lord Shuttleworth and Sir J. P. Griffith are among those who have promised to read papers, while Mr. Neville Chamberlain and Sir J. Brunner are among those who are expected to speak on the subject. A paper by Professor S. J. Chapman will deal with progressive taxation, and Professor A. W. Kirkaldy will consider the economic effects of the opening of the Panama Canal. Professor A. L. Bowley will contribute to the discussion on the cost of living a paper on the relation between wholesale and retail prices, with special reference to working-class expenditure, and Mr. Cuthbertson will contribute a paper on working men's budgets.

ELECTRIC RAILWAYS AND WIRELESS SIGNALS

In Section G (Engineering) the presidential chair will be occupied by Professor Gisbert Kapp. His address will deal with the electrification of main lines of railway. The treatment will be non-mathematical, and will be theoretical only in so far as it is necessary to develop certain features on a scientific basis. In the main the address will be a statement of what has actually been accomplished in this country and on the continent, including technical details

of lines and electromotives, tables of weights, speeds, acceleration, etc. The electromotives of the Loetschberg Tunnel line just opened will be among those dealt with in the address. The committee on gaseous explosions will present its report during the meeting, and among many individual contributors to the proceedings will be Professor Marchant with a paper on some effects of atmospheric conditions on wireless signals; Professor Howe, who will discuss the nature of the electro-magnetic rays employed in radio-telegraphy and the mode of their propagation; Mr. F. W. Lanchester, who will deal with the internal-combustion engine as applied to railway locomotives and will also have something to say about aeronautics; and Professor Burstall, who has promised a paper on solid, liquid and gaseous fuel.

The administrative value of anthropology will be the subject of Sir Richard Temple's presidential address to Section H (Anthropology). He proposes first to explain the nature and scope of the science as at present understood, the mental equipment necessary for the useful pursuit of it, and the methods by which it can be successfully studied. Next he proposes to deal with the extent and nature of the British Empire, the kind of knowledge of the alien populations within its boundaries required by persons of British origin who would administer the empire with benefit to the people dwelling in it, and the importance to such persons of acquiring that knowledge. Lastly he proposes to note the steps taken or suggested by the Royal Anthropological Institute and the universities of Cambridge and Oxford towards the supply of the knowledge of mankind necessary for sound imperial administration, which, to his mind, is the practical result of the studies of anthropologists. The programme of papers to be submitted to the section includes communications from Dr. H. R. Rivers on sun cult and megaliths in Oceania, and from Dr. Landtman on the ideas of the Kiwai Papuans regarding the soul. A contribution with an important bearing on the history of human sacrifice will be a description by Mr. J. H. Powell of the ceremony of hook-swinging in India, with lantern illustrations. The influence of geographical environment on religious development in northern Asia will be the subject of consideration by Miss Czaplicka, while Major Tremearne will deal with the magic of the Nigerian Hausas.

ARCHEOLOGY AND PHYSIOLOGY

British archeology will be well represented, as also will the results of archeological research in other parts of the world. Dr. Capitan, of Paris, who will be among the foreign guests, will describe paleolithic paintings recently discovered in the south of France; Professor Flinders Petrie will describe the results of his last season's work; and Dr. T. Ashby, of the British School at Rome, will present a report on a recent examination of the archeological remains in connection with the Appian Way and some fresh material bearing on the system of aqueducts in Rome. A paper of great importance as an example of the statistical method will be presented by Professor H. G. Fleure and Mr. T. C. James, dealing with the physical characters of the people of Wales and the borders.

The president of Section I (Physiology) will be Dr. F. Gowland Hopkins, F.R.S. During the meeting the section will receive the report of its committee on anæsthetics, in connection with which Sir Frederic Hewitt will speak on the subject of the state regulations of anæsthetics. The feature of the proceedings will be the number of joint meetings with other sections, demonstrating the close relation between dif-

ferent branches of science. There will be a meeting with the agricultural section to discuss the physiology of reproduction, with special reference to the factors affecting fertility and sterility in livestock. Reference has already been made to the joint meeting with the zoological and botanical sections. It is hoped to arrange a joint meeting with the chemical section for a discussion on fermentation. Finally the subsection of Psychology will hold a joint meeting with the Educationists. In individual papers Mr. W. McDougall will discuss the theory of laughter; Miss M. Smith and Mr. McDougall will communicate a paper on memory and habit; Dr. J. L. McIntyre will discuss the effects of practise on the memory of school children; Mr. Stanley Wyatt will report the results of some investigations into the reliability of children's testimony; and Mr. T. H. Pear will report on recent experiments regarding the psychology of testimony.

Section K (Botany) will present the rare, if not the unique, spectacle in the history of the association of being presided over by a lady. In her address to the section Miss Ethel Sargant will deal with the subject of plant embryology, considering recent work on the subject and its bearing on various morphological problems. A semi-popular lecture will be delivered by Professor W. H. Land, F.R.S., on Epiphyllous Vegetation, and there will be a joint discussion with the agricultural section on problems in barley production. A joint meeting, as already stated, has been arranged with the zoologists and physiologists. Like the zoologists the botanists will engage in an excursion to the Burbage Experimental Station, and another excursion will be made to Sutton Park.

EDUCATIONAL SCIENCE

Principal E. H. Griffiths will preside over Section L (Educational Science). In preparing his address his object has been to make an inquiry as to the general feeling with regard to the success of our educational system, with special reference to primary education. He has collected the opinions of business men and teachers and has found the prevailing atmosphere to be one of pessimism. Venturing further afield he has made detailed inquiries of all the directors of education in the kingdom. Replies have been received from 112 directors, representative of every kind of authority in all parts of England and Wales. These replies are confidential, but they provide the basis for certain conclusions which will be set out in the address and which will, it is hoped, be found useful at a time like the present, when it seems as though our educational system is in the melting pot. Principal Griffiths will urge in his address that we are making the mistake of over-estimating knowledge and under-estimating character; that it would be better if we could model our educational system more on the boy scout movement, that is, cultivate character and intelligence until the desire for knowledge is established. Touching briefly on matters connected with secondary and higher education, he will suggest that what we want is a more careful sifting of the products of the primary schools so as to ensure that only those who are really fitted to receive secondary education should be helped by the state to obtain it; that a more careful system of selection should be established, and that when the fittest have been found more generous help should be given when necessary. As regards the universities, the danger of their passing under state control will be pointed out.

As usual, the section will follow the wise practise of discussing a few subjects of large importance rather than receiving a

multitude of disconnected papers. As an outcome of suggestions made at the Dundee meeting the section will meet with the anthropologists to discuss the educational value of museums. A discussion on the function of the modern university in the state promises to be very attractive, as the heads of the newer universities, including Sir Oliver Lodge, have promised to take part. The president of Stanford University, Mr. Alfred Mosely and Miss Burstall, of the Manchester High School for Girls, are also expected to contribute to the discussion. The discussion arranged with the psychological subsection of Section I will be concerned with the general question of the need for research in education, and with the specific researches which have been made into the vexed subject of the psychology of spelling. Two other discussions will be concerned with manual work in education and the registration of schools. The importance of the latter question was brought out by a committee at the Dundee meeting, while the importance attached to manual training is shown by the new emphasis which is now being laid on it in educational practise.

Professor T. B. Wood will preside over Section M (Agriculture). In his address he proposes to review the results of twenty years' work in agricultural science, to point out the successes and failures, to discuss the reasons for success or failure, and to endeavor therefrom to make suggestions for the future. As already stated, the section will engage in joint discussions with the botanists (on barley culture) and the physiologists (on the physiology of reproduction). Communications will also be made to the section by Sir Richard Paget, on the possibilities of partnership between landlord and tenant; Professor Fraser Story, on German forestry methods; Dr. H. B. Hutchinson and Mr. K. McLellan, on the partial sterilization of soil by means of caustic lime; and Dr. Winifred E. Brenchley, on the weeds of arable land.

THE PRINCIPLE OF MENTAL TESTS

THE standpoint of applied psychology is implicit in the conception of mental tests. They represent a group of procedures, usually of simple technique, developed so that our knowledge of individual differences may, as Cattell puts it, be employed to guide human conduct. To justify themselves, they must earn their bread in terms of usefulness for the questions of life. In this respect they differ from the leisure-class problems of true psychological science, which are exalted above these vulgar necessities.

Two broad functions of psychological tests are distinguished. One is the measurement of changes in individuals under controlled differences in experimental conditions. The studies of Hollingworth on caffeine and of Winch on the effects of school work are among the recent examples of this type. Here the problem has usually been defined in the determination of central tendencies. To this limit, measurements can be made with comparative reliability, because the external conditions are well controllable, and the errors due to subjective factors tend, on the whole, to compensate. That is, a gain of 10 per cent. in the same individual for a second performance represents a gain of 10 per cent. in the same abilities as were concerned in the first performance. The more difficult question of just what these abilities represent in the individual case has been a secondary one for these studies, not usually coming into prominence.

It must be squarely faced, however, in the other function of psychological tests, that of measuring and interpreting the differences between individuals under similar immediate conditions. One may not say because Peter is 10 per cent. better in a memory test than Paul, that it is due to a 10 per cent. superiority in the same abilities as Paul's. It is not a difficult matter to construct tests in which consistent and certain individual differences ap-

pear. The quicksand begins at the next step; that of constructing tests which shall have a useful meaning. Individual differences in the tapping test are exquisitely clear through many aspects of the experiment; but what these individual differences represent in the personality of the subject we do not know. The problem of mental tests is duplex; to construct a test at once free from physical and physiological inaccuracies, and one that shall have a useful significance for the subject's adaptation to life. Without the first the second is unattainable; without the second the first is futile.

The questions of interpretation must not be taken too lightly. Psychological experiments of the present class must consistently represent those mental properties of the individual that it is desired to compare, properties such as it is useful to know about. The value of mental tests depends upon their correlation with the personality of the subject; and the essential task in the scientific development of any mental test is to determine how well it indicates some phase of the subject's personality.

Because it is much easier to do, we have been apt to develop handy psychological methods and then try to make them mean something, rather than to start from the things that are important to know, and trying to develop methods for determining them. But to start with the tapping test as a measure of voluntary motor ability, or with the A test as a measure of rate of perception, is too obviously approaching the problem at the wrong end. We must not be bound by the notion that one test tests one thing, another test another; one test usually tests several things, and it must take several tests to test one thing well. First must be known the direction our inquiries must take; a task whose extreme complexity demands analytical and systematic observation of human behavior, not to mention insight. Then one may seek to develop measures which shall be themselves reliable, and shall show the most constant relation to the elementary traits that are to be measured. The test is never an ultima ratio. If we want to determine how good a test the average daily wage is of the number of applicants for poor relief, we must have other, most reliable information of the number of such applicants. In the same way, in order to know how far any mental test is a reflection of personality, we must have accurate knowledge, from other experiential sources, of how this personality compares with others in the phase we may be testing.

Mental faculties differ a great deal in the completeness with which they are experimentally covered. Those mental tests are of the best assured value where the use made of the method is immediate so to speak in terms of its own result. Thus we may interpret a test of astigmatism in terms of its own result, because it represents a nearly constant attribute of the individual, unaffected by other uncontrolled factors. A test of color-blindness can be interpreted in terms of its own result, to decide on the fitness of the subject for railway or marine service. But this is not so much the case with the strength tests, such as are used in the gymnasiums. A person may test quite high on the dynamometers who can not make nearly so efficient use of his strength, or actually not be so strong, as one who can not make so good a record with them. Practical life puts the eyes to the same test that the Snellen types do, therefore they are a good test; it does not put the muscles to the same test that the dynamometers do, therefore they are an inferior test.

There is in our experimental literature a happily growing tendency, as exemplified in the work of Healy, G. G. Fernald, Simpson, and others, to submit the tests of the higher mental processes to the test of concrete experience. The most prominent result of this Fragestellung has been the series of graded tests. We wish to be able to say that a child has in certain ways the ability of an 8, 9 or 10 year old. Therefore we determine what degree of these abilities is actually characteristic of 8, 9 or 10 year old children. Just as, if we wished for a test of honesty, we should try to find some way in which persons known to be honest differed from persons known to be dis-

honest. Of course the child is ten years old only in those respects covered by the tests. And the striking results reported by Miss Weidensall at Cleveland illustrate that there are other mental factors, most important for adaptation to life, that are not reached even by the inclusive scope of the Binet tests.

This fundamental weakness, one which is shared very liberally with the remainder of mental tests, seems to be that they are too much concerned with processes that for want of better names we sum up under intellectual capacity and intelligence. External competence, not to speak of subjective balance, depends also upon the capacity to make the intellect effective in the vital activities. An important further obstacle to making it thus effective arises when accompanying feelings are such as to make the proper reactions in any way disagreeable or less agreeable than other reactions which are less objectively adequate.

It is difficult to estimate how much of the significance in our present mental tests may be lost through failure to attend to these factors. Three persons go through the number-checking test; one in 140 seconds, the other two in 100 seconds. But the check-marks of the first two are all made in consecutive order, at regular intervals, while the third works erratically, skips back and forth, marks now very fast, now very slow. Probably this subject differs from the second far more significantly than the second does from the first. Any one might have the highest intellectual standing. The regularity with which a voluntary task is performed, the attentional control over it, and its freedom from subjective interference is to my mind a far more important thing to observe than the absolute efficiency in some task but remotely connected with really vital reactions.

Yet most of our psychological tests pretend to measure maximal capacities of some sort, and this maximal capacity is taken to indicate the subject's essential response to the test. It is so in some simple tests, as those of the astigmatism type; but when the test is more complex, as the above-mentioned, gross efficiency is the product of many factors that are to be interpreted only on the basis of other, more analytical controls. This is only a part of the subject's whole reaction to the test, and is the less important part the less the test is related to the struggle for existence. In these tests it is not so important how much the subject does as what he does. The manner of dealing with the situation represents the more fundamental traits; four minutes of method with Healy's puzzle box is better than two minutes monkey-fashion. But because these factors are exceedingly difficult to describe and measure, the workers dealing with mental tests, who as a class are occupied with large masses of data gathered with relative perfunctoriness, are apt to pass them by.

The adequate interpretation of mental tests further requires that we understand their relation to the subject's emotional reactions. It is interesting to know that you can methodically take up Healy's puzzle-box and open it in fifty seconds; but it is far more important to know whether, if you were caught in Healy's puzzle-box, and expected your enemy at every moment, you would preserve the same effectiveness of your reactions towards it. In what ways and to what extent is affective sensibility manifested in the subject? How much does the effectiveness of a performance depend upon its position in the affective scale? How to measure this is what we are responsible for finding out; though I venture to predict that the answers, of which there will have to be many, will come not so much in terms of a capacity, like addition, or memory, as in terms of a tendency, like the individuality of free association responses, or the types in arrangements of relative position scales.

What has the author tried to do—how has he done it, and—is it worth doing? This is the framework on which we used to be told to construct a review. And so in reviewing the question of mental tests, it is endeavored to indicate that their proper task is the measurement of functions concerned in the mental adaptation to life, and how they can best perform it through giving a well-proportioned recognition to the intellectual, volitional and affective spheres. How much it is worth doing

is unwise to speculate on where it has been very inadequately done. The crucial question is if it will always be necessary, in order to correctly interpret our tests, to already know so much about our subject, that the test gives us no added information. To-day this is true in all the more complex mental processes; and it is not improbable that, as our tests are improved, a better understanding of human conduct at large will develop. This brings more into the foreground the quantitative features of experiment; to tell us something good to know more accurately than we could otherwise know it. It is the form and direction of the tests that has to be dealt with now. If we do not first interpret our tests by our subjects, we shall never understand our subjects through our tests.

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THE FOURTH INTERNATIONAL CONGRESS OF SCHOOL HYGIENE

As has been already announced the fourth international Congress of School Hygiene meets at Buffalo from August 26 to 30. The congress is under the patronage of the president of the United States and Dr. Charles W. Eliot is the president. The vice-presidents are Dr. William H. Welch and Henry P. Walcott. The secretary-general is Dr. Thomas A. Storey, College of the City of New York, New York City, U. S. A., from whom programs and further information can be obtained. The congress meets in three sections, for each of which a large number of papers is announced on the preliminary program. The sections and the subjects covered are as follows:

Section 1. "The Hygiene of School Buildings, Grounds, Material Equipment and Upkeep." This section will include papers on topics related to the location, plan, construction, equipment and up-keep of city, village and rural schools, open-air schools, private schools, boarding schools, summer camps and special schools for backward, truant, delinquent, deficient, defective and deformed children, *i. e.*, site, architecture, decoration, ventilation, illumination, cleaning system, plumbing, toilets, sewage disposal, school furniture, school books, water supply, drinking facilities, bathing facilities, swimming pools, school grounds, school athletic fields, fields for games, sport and play, lunch rooms and equipment, gymnasium, social rooms, rest rooms, libraries, laboratories, class rooms, study rooms and lecture rooms.

Section 2. "The Hygiene of School Administration, Curriculum and Schedule." This section will include all topics concerned with the hygienic factors found in school administration, curriculum and schedule as they apply to country, village and city schools; and to the modifications necessary for the best interest of our various special schools. Papers on such subjects as the following would belong to this section: Hygiene of the teacher; hygiene of the child; hygiene of the janitor and other school employees; hygiene of the schedule, growth and age; school fatigue; need for and management of school lunches and school baths; influence of the seasons; study periods; home work; recesses; vacations; athletics; the problems of heredity in relation to school hygiene; overcrowding; the teaching of hygiene; the training of teachers of hygiene; special phases of hygiene: as personal hygiene; oral hygiene; preventive hygiene; educational hygiene; community hygiene; sex hygiene; play; physical education; domestic hygiene; puericulture, and first aid; special plans for and results from the instruction of backward children, truant, delinquent and crippled children; the economics of school hygiene; relation to the home.

Section 3. "Medical Hygienic and Sanitary Supervision in Schools." This section will receive papers on the management, operation and results of medical, hygienic and sanitary supervision in public, private and special, country, village and city schools, colleges, universities and professional schools.

Such subjects as the following will be included: The control of health inspection; sanitary supervision; the organization of health departments in schools; the relationship to the board of health; the equipment, training

and compensation of school physicians; school nurses; school clinics; relation of health supervision in the schools to the practise of the physician, the dentist and the hospital; relation of medical and hygienic supervision in the schools to health supervision in the home; standardization of examinations; sanitary supervision of school rooms (class rooms), locker rooms, swimming pools, toilets, school books and school furniture; supervision of disease carriers; prevention of epidemics; follow-up methods and results; medical inspection and treatment; standardization of records.

SCIENTIFIC NOTES AND NEWS

McGILL UNIVERSITY held a special convocation on August 2 for the purpose of conferring honorary degrees in connection with the visit of the International Geological Congress to Canada. The degree of doctor of laws was conferred as follows: Helge Bäckström, Ph.D., professor of mineralogy and petrography in the University of Stockholm (presented by Professor Howard Barnes, F.R.S.); Alfred Bergeat, Ph.D., professor of geology in the University of Königsberg (presented by Professor Dale, M.A.); Alfred Harker, M.A., F.R.S., university lecturer in petrology in the University of Cambridge (presented by Professor John Macnaughton, LL.D.); James Furman Kemp, D.Sc., professor of geology, Columbia University, New York (presented by Professor McLeod, F.R.S.C.); Alfred Lacroix, D.Sc., professor of mineralogy at the Museum of Natural History, Paris (presented by Dean Adams, F.R.S.).

PROFESSOR W. A. BONE, F.R.S., has been awarded the Howard N. Potts gold medal for distinguished work in science or the mechanic arts by the Franklin Institute of Philadelphia, in recognition of his work upon surface combustion.

MR. JOHN TEBBUT, who has conducted a private observatory at Windsor, N. S. W., has recently celebrated two anniversaries, having entered on his eightieth year, and completed fifty years' membership of the Royal Society of New South Wales.

DR. HOMER DOLIVER HOUSE, associate director and lecturer on botany and dendrology of the Biltmore Forest School, has received the appointment of assistant state botanist of New York.

MR. A. R. HINKS, F.R.S., of the Cambridge Observatory, has been appointed assistant secretary of the Royal Geographical Society.

ACCORDING to *The Observatory* Mr. Edward Kitto has retired from the superintendence of the Falmouth Magnetic and Meteorological Observatory. In consequence partly of financial difficulties, the work of the observatory under its present constitution came to an end on June 30, but the department of terrestrial magnetism of the Carnegie Institution of Washington has arranged to carry on some of the observations for a few months longer.

SURGEON-GENERAL SIR DAVID BRUCE, head of the sleeping sickness commission which was sent to Central Africa nearly two years ago, has returned to England with Lady Bruce. Sir David will in a few weeks return to Nyasaland, where the other members of the commission are still working.

MR. CHARLES H. T. TOWNSEND, who was some time since especially charged by the Peruvian government with the investigation of the insect transmission of verruga, injected a dog with triturated females of *Phlebotomus* on July 11, and on July 17 secured as result an unmistakable case of verruga eruption. The gnats used for the injection were secured on the night of July 9 in Verrugas Canyon, a noted focus of the disease. This is the first experimental transmission of verruga by means of insects, and adds a notable case to the list of insect-borne diseases. The details of the experiment will appear shortly. Further transmission work in laboratory animals will be pursued at once, both by injections and by causing the gnats to bite.

FREDERICK G. CLAPP, managing geologist of the Associated Geological Engineers of Pittsburgh, Pa., and Alten S. Miller, of Humphreys & Miller, New York City, are examining the gas fields of Hungary in company with Professor Hugo Bockh, of that country.

Professor Vladimir Karapetoff, professor of electrical engineering at Cornell University, has started on a trip for the purpose of visiting hydro-electric developments and high-tension power transmission plants. He expects to visit the recent development on the Mississippi River at Keokuk, Iowa, and then go to Denver, Salt Lake City, Los Angeles, San Francisco, Portland and Seattle, and to attend the Pacific Convention of the American Institute of Electrical Engineers in Vancouver, B. C., September 9–13.

A French Arctic expedition, headed by Jules von Payer, sailed on August 10 for the purpose of exploring and gathering scientific data in Franz Josef Land.

Under the auspices of the Edinburgh Mathematical Society, a colloquium was held in Edinburgh from August 4 to 9, when courses of lectures were given on "Relativity and the new physical ideas of space and time," by Professor Conway; on "Non-Euclidean geometry," by Dr. Sommerville, and on "Harmonic and periodogram analysis," by Professor Whittaker.

A bronze panel has been unveiled at Lugar, Ayrshire, Scotland, in memory of William Murdoch, one of the inventors of coal-gas lighting. The panel, which takes the form of a life-size portrait medallion in bold relief, was placed on the wall of the cottage in which Murdoch was born.

The last legislature of the state of Pennsylvania appropriated $100,000 for the control of the chestunt bark disease during the biennium 1913–14. Governor Tener, after consulting with the Chestnut Tree Blight Commission, felt that this sum was inadequate for their task, and vetoed the appropriation. It is expected, however, that all the research work of the commission will be continued, in cooperation with the Bureau of Plant Industry.

The Independent quotes the following items from its issue of fifty years ago:

Professor Wolcott Gibbs, an able chemist, has been chosen Rumford professor at Harvard University. Columbia College a year or two since refused to appoint him to a chemical professorship. Because he did not understand chemistry? No; because he was a Unitarian! This is as if you should refuse to get your clothes of the best tailor because he did not make jack knives to suit you.

Mr. Cyrus W. Field has gone to England in furtherance of his favorite Atlantic Telegraph enterprise. Both ends of the proposed telegraph line are to be under the control of England. No American is a real friend of his country who will give a cent to help England at present to such a tremendous military engine as that.

The appointment of Professor C. F. Marvin as chief of the weather bureau of the Department of Agriculture made by the President of the United States was noted in Science last week. Before the secretary of agriculture nominated Professor Marvin for this position he had carefully considered a large number of names suggested from all sources and had sought the advice of a number of university administrators and scientific men and had asked the National Academy of Sciences to make recommendations. A committee of the National Academy gave the matter very careful consideration and its opinions were communicated to the secretary, who since has expressed his appreciation of this assistance. The committee of the National Academy of Sciences unanimously recommended the appointment of Professor Marvin. Meanwhile, the department, through its own sources of information, had come to the conclusion that Professor Marvin was the best man available for the position. Professor Charles F. Marvin was born in Putnam, Ohio, October 7, 1858. He graduated in mechanical engineering from the Ohio State University in 1883. He was instructor in mechanical and physical laboratory practise at this university for some time. He was appointed on the civilian corps of the signal service in 1884. On July 1, 1891, he was transferred to the Department of Agriculture when the weather bureau service was transferred, and was professor of meteorology. Professor Marvin has made important investigations of anemometers for the measurement of wind velocities and pressures, and on experiments conducted by him the tables used by the weather bureau for deducing the moisture in

the air are based. He has also invented important instruments for measuring and automatically recording rainfall, snowfall, sunshine, atmospheric pressure, evaporation, etc. He has made extensive studies in, and written on, the use of kites for ascertaining meteorological conditions in the free air, the registration of earthquakes, the measurement of evaporation, solar radiation, etc. He was detailed for special purposes to the Cotton States and International Exposition at Atlanta in 1895, to the Tennessee Centennial Exposition at Nashville in 1897, and to the Jamestown Exposition in 1907. In February, 1900, he was appointed a representative of the Department of Agriculture at the Meteorological Congress held in connection with the International Exposition at Paris. For some time he has been in charge of the instrument division of the Weather Bureau, an important branch of the department.

The British secretary of state for the colonies has nominated a committee to report: (1) Upon the present knowledge available on the questions of the parts played by wild animals and tsetse flies in Africa in the maintenance and spread of trypanosome infections of man and stock. (2) Whether it is necessary and feasible to carry out an experiment of game destruction in a localized area in order to gain further knowledge on these questions, and, if so, to decide the locality, probable cost, and other details of such an experiment, and to provide a scheme for its conduct. (3) Whether it is advisable to attempt the extermination of wild animals, either generally or locally, with a view of checking the trypanosome diseases of man and stock. (4) Whether any other measures should be taken in order to obtain means of controlling these diseases. The committee will be composed as follows: Lord Desart (chairman); Mr. E. E. Austen, British Museum (Natural History); Dr. A. G. Bagshawe, Director of the Tropical Diseases Bureau; Dr. Andrew Balfour, late director of the Wellcome Research Laboratories, Gordon College, Khartum; Sir John Rose Bradford, secretary of the Royal Society; Mr. E. North Buxton; Dr. W. A. Chapple, M.P.; Sir Mackenzie D. Chalmers; Lieutenant-Colonel Sir W. B. Leishman, professor of pathology, Royal Army Medical College; Sir Edmund G. Loder, vice-president of the Zoological Society; Dr. C. J. Martin, F.R.S., director of the Lister Institute of Preventive Medicine; Mr. J. Duncan Millar, M.P.; Dr. P. Chalmers Mitchell, secretary of the Zoological Society; Professor R. Newstead, Liverpool University; Mr. H. J. Read, of the Colonial Office; the Hon. L. Walter Rothschild; Sir Stewart Stockman, chief veterinary office, Board of Agriculture and Fisheries; Mr. A. C. C. Parkinson, of the Colonial Office, will act as secretary.

The production of coal in 1912 reached the great total of 534,466,580 short tons, valued at the mines at $695,606,071, according to a statement by Edward W. Parker, coal statistician, just issued by the United States Geological Survey. This year the report on the coal industry of the United States begins the fourth decade in which coal statistics have been published annually by the Geological Survey. In 1882, the first year of this period, the total coal production of the United States had reached what was then considered about high-water mark—103,551,189 short tons. In 1912 the production of bituminous coal alone in the state of Pennsylvania exceeded that figure by nearly 60 per cent. and the combined production of bituminous coal and anthracite in Pennsylvania in 1912 was two and one quarter times the total production of the United States in 1882. The total coal production of the United States in 1912 was more than five times that of 1882. In 1882 the United States was a poor second among the coal-producing countries of the world, Great Britain having an output exceeding that of this country by nearly 70 per cent. The United States supplanted Great Britain as the premier coal-producing country in 1899, and in 1912 it was as far ahead of Great Britain as that country was ahead of the United States in 1882. The United States at present is contributing 40 per cent. of the world's supply of coal and is consuming over 99 per cent. of its own production. In 1912 the production of coal in the United States not only surpassed all previous

tonnage records, but the average value per ton exceeded that of any normal year in the 33 years for which statistics are available. There has been only one year when prices generally were higher than in 1912, and that was 1903, the year of the fuel famine. The gain in output in 1912 over 1911 was 38,095,454 short tons and the increase in value was $69,040,860. The production of bituminous coal increased from 405,907,059 short tons to 450,104,982 tons, a gain of 44,197,923 tons, with an increase of $66,607,626 in value. The decreased production of anthracite, amounting to 6,102,469 short tons, was due entirely to the suspension of mining in April and May, when practically the entire region was idle. The factors which contributed to the increased output of bituminous coal were (1) the revival in the iron and steel industry, which stimulated production in the Eastern States, the coal made into coke showing, alone, an increase of nearly 6,000,000 tons; (2) bumper crops of grain and other agricultural products, which gave prosperity to the farming communities of the Middle West; (3) decreasing supplies of natural gas and fuel oil in the mid-continent field and their consequent lessened competition with coal from the southwestern states; (4) increased consumption by railroads and in nearly all lines of manufacturing; (5) activity in the mining and smelting of the precious and semiprecious metals in the Rocky Mountain and Pacific states. These factors combined made the year 1912 one of the rather rare prosperous years in the mining of bituminous coal.

In the House of Commons on July 24 Mr. Runciman gave, as we learn from *Nature*, an account of the work of the Board of Agriculture during the past session. Arrangements have been made for research on agricultural subjects to be carried on at a number of centers, including Rothamsted, Manchester, Birmingham, Oxford, Cambridge, the Royal Veterinary College, Leeds, Wye, Bristol and Kew, and grants amounting to £20,000 a year have been made for the purpose. In addition, £3,900 has been given for special investigations lying outside the scope of the program of the special institutes. All these investigations have reference to the great fundamental problems lying at the root of the agricultural and horticultural work of the country; the work is wholly scientific. In order to bring the scientific results into the region of practical farming a number of advisers have been set up whose function it is to advise farmers or county organizers in the light of the results of the scientific knowledge that is gained. A grant of £9,000 per annum has been made towards the salaries of these advisers.

The *Geographical Magazine* describes an important project for the construction of a vast port for the city of Milan destined to meet all possible future developments of internal navigation. The municipality has expressed approval of the project, and intends to apply to the state for powers to carry it into execution. Detailed studies have been carried out by MM. Beratta and Maiocchi, who, from wide experience of the most important riverports of other European countries, have drawn up plans for the proposed port in respect of quays, wharfs, warehouses, railway and other communications, docks, workshops and installations of all kinds on the most approved modern principles. The total area to be covered by the port is 112 hectares (277 acres) of which about 50 acres will be occupied by the basins, an equal area by roads, railways, etc., 25 acres by the stations and the remainder by the quays. It is hoped to begin operations at an early date, so that the port may be ready by the completion of the great Venice-Milan waterway, which is to give passage to vessels of up to 600 tons burden.

The federal Lighthouse Bureau and the Forest Service are cooperating in forest work on the shores of the great lakes in the lumber states of Michigan and Wisconsin. The lighthouse reservations here include a total of nearly 5,500 acres, and range in size from 30 acres at Grand Island, Michigan, to 1,040 acres at Grand Marais. An examination is just being started to determine the best forest methods to pursue on the reservations. On some, from which the timber has been cut, white pine and Norway pine will be planted. On others the timber already growing will be

preserved through use. On two of the reservations, the forest experts point out, the opportunities are excellent for growing cedar and pine for spar buoys and piling, to be used in the work of the Lighthouse Bureau itself. All parts of the reservations can not be devoted to forests. Some areas will have to be left clear for protection from fire, while others immediately adjacent to the beacons themselves will have to be left bare in order that the lights may not be obscured.

A CONTRIBUTION on the great glaciers of Alaska is Bulletin 526 of the U. S. Geological Survey, "Coastal Glaciers of Prince William Sound and Kenai Peninsula, Alaska," by U. S. Grant and D. F. Higgins. The report is profusely illustrated with photographs and with maps of the individual glaciers, as well as two comprehensive maps of Prince William Sound and the southwestern part of Kenai Peninsula, showing the location of scores of glaciers. The report is in fact a guide and handbook to this wonderful scenic region which must prove invaluable to the tourist. Many valuable data and important measurements of glaciers in the United States, Alaska and elsewhere have been brought together from time to time, and it is probably the general impression that since the vast ice sheet which covered the northern part of North America began its retreat the glaciers of the continent have been continually shrinking. It is therefore interesting to note from the illustrations and descriptions in Bulletin 526 that some of these Alaskan glaciers are progressing and growing larger rather than retrogressing, many huge forests being upturned and devastated by the irresistible advance of the ice. In other glaciers the retreat within a period of ten years has been more than a mile. The great magnitude of some of these glaciers is seen in the descriptions, which indicate the height of the tidal ice cliffs that form the termini of the glaciers as being from 300 to 400 feet. Slowly moving down the mountain valleys, some of them steeply pitched and others relatively flat, these stupendous ice fields include billions of tons of ice. Many young Americans can find here memorials of their alma mater, for along College Fiord are Yale Glacier, Harvard Glacier, Smith Glacier, Bryn Mawr Glacier and Vassar and Wellesley glaciers.

UNIVERSITY AND EDUCATIONAL NEWS

As noted in SCIENCE last week, the governor of Pennsylvania has signed a bill appropriating the sum of $1,226,000 for the next two years, to the Pennsylvania State College. Two years ago the college received $800,000, out of which $200,000 was to be applied for the purpose of paying off a long-standing debt, so this year's appropriation is practically double that given two years ago. This is only in keeping with the great increase in students, as last year's enrollment, including summer school for teachers, was 2,535. The increase has been among the largest in the United States.

PROFESSOR LYMAN P. POWELL, head of the ethics department at New York University, has accepted the presidency of Hobart College.

THE following resignations have recently occurred at the Alabama Polytechnic Institute: Professor Jesse M. Jones, recently appointed head of the department of animal industry, has resigned to become field agent in cooperative farm demonstration work in the states of Maryland, Kentucky and West Virginia for the U. S. Department of Agriculture. L. W. Shook, formerly field agent in live stock work, has resigned to accept a similar position with the North Carolina Station, and Mr. T. C. Bottoms, herdsman, has resigned his position to take up similar work at the same station. Mr. J. M. Johnson, assistant in the department of animal industry during the past year, has resigned to pursue graduate work in the University of Missouri.

DR. G. E. GIBSON, of the University of Edinburgh, has been appointed instructor in chemistry in the University of California.

MR. R. A. JEHLE, of the Kansas State Agricultural College, instructor in plant pathology, has been appointed instructor in plant pathology at Cornell University.

PROFESSOR R. M. BROWN, of the geography department of the State Normal School, Worcester, Mass., has been appointed as head of

the department of geography at the Rhode Island Normal School, Providence, R. I.

At University College, Reading, Mr. S. B. McLaren, assistant lecturer in mathematics at Birmingham University, has been appointed professor of mathematics, and Mr. R. C. McLean lecturer in botany.

DISCUSSION AND CORRESPONDENCE

THE NAME OF THE SHEEP MEASLE TAPEWORM

Cobbold in 1866 described a cysticercus from the muscles of sheep in England and named it *Cysticercus ovis*. The same species was later described by Maddox (1873) under the name of *Cysticercus oviparicns*. Other authors have considered the parasite to be either *Cysticercus cellulosæ*, the intermediate stage of *Tænia solium*, in an unusual host, or *Cysticercus tenuicollis*, the intermediate stage of *Tænia marginata* or *hydatigena*, in an unusual location (muscles instead of serous membranes). Recent investigations by the present writer have proved that the parasite in question is neither *C. cellulosæ* nor *C. tenuicollis* but the intermediate stage of a distinct species of dog tapeworm. The correct name of this tapeworm would, therefore, seem to be *Tænia ovis* (Cobbold, 1866). B. H. Ransom

Bureau of Animal Industry,
Washington, D. C.

NOTE ON THE ORIENTATION OF BOMBILIUS TO LIGHT

While on the hills east of Berkeley, Cal., I observed, among numerous insects visiting the flowers of certain shrubs, that there were several flies which kept hovering for a considerable time in almost exactly the same position. The flies proved to belong to a species of *Bombilius*. The instinct of hovering is not rare among the Diptera, especially the Syrphidæ, but what especially attracted attention was the accurate orientation of the hovering insects to the rays of light. In all the numerous cases observed the flies had their backs turned toward the sun, and in all cases the hovering occurred in the direct sunlight. Whenever a shadow was thrown upon a hovering fly it immediately darted elsewhere.

Occasionally the flies alighted on the ground, when they rested with the back exposed to the sun as before. When a shadow was thrown on them they would soon fly to a sunnier spot. In a few cases I caused them to orient obliquely to the sun's rays by slowly moving an object so that its shadow was thrown on only half the body of the insect; the body would then be turned so as to face more nearly the center of the shaded region. In basking in sunny spots and in orienting negatively to the rays of light the behavior of *Bombilius* resembles that of the mourning-cloak and other butterflies described by Radl and Parker. Like the mourning-cloak, *Bombilius* under ordinary circumstances is positively phototactic. It will fly or walk toward the light as so many other Diptera do, but when resting on the ground in the sunshine or hovering in the air it assumes a negative orientation. It is of interest to find such striking similarities of behavior in two distantly related orders of insects.

When resting on the ground or hovering, *Bombilius* often darts quickly at passing insects. It is not very discriminating as to the objects of its approach and was several times seen to follow after honey-bees and twice after yellow-jackets. When the fly meets a member of its own species the two often spin around in a rapid whirl, but when a mistake is made the pursuit is immediately abandoned. I have caused *Bombilius* as well as other species of hovering flies to dart after small pebbles that were tossed in the air. This behavior is probably associated with the instinct of mating, since it occurs in nonpredatory as well as predatory species.

S. J. Holmes

SCIENTIFIC BOOKS

Handwörterbuch der Naturwissenschaften. Herausgegeben von E. Korschelt, *Zoologie;* G. Linck, *Mineralogie u. Geologie;* F. Oltmanns, *Botanik;* K. Schaum, *Chemie;* H. Th. Simon, *Physik;* M. Verworn, *Physiologie,* und E. Teichmann, *Hauptredaktion.* Jena, Verlag von Gustav Fischer. 1912.

In order to review a book it is at least extremely desirable to have read it. Reading the encyclopedia is not "jedermann's Sache" and, unlike Agamemnon in the story of the Peterkin family, the present writer can not pretend to have done it, but he has at least carefully examined each of the forty-six "Lieferungen" of 160 pages each, which have so far appeared of this admirable work, and has perused with care many of the articles on which he is competent to have an opinion. The first thing that must certainly strike the scientific man on opening this work is the feeling of regret that it is impossible to produce such a work in America, and, secondly, that, if it were, no publisher could be found to undertake it, for the, to him, very convincing reason that he would not be able to make any money out of it. Germany is preeminently the country of encyclopedias, and if one can judge of German greatness from the thoroughness with which they go about the manufacture of these aids to knowledge he can but wonder why the Germans have not already conquered the world. To be sure France is the home of what must always be known as *the* encyclopedia, to say nothing of Larousse and similar undertakings, and England is the home of eleven editions of the Britannica, to which in these latter days American methods of scientific management and booming have been added as well as British and American learning; but when we look at the "Encyclopaedie der mathematischen Wissenschaften," which has been appearing now for thirteen years, and is not yet complete, and which has compelled the French to publish a French edition based with great fidelity upon it, we must admit the impossibility of competition in this line.

The present work is, so far as known to the reviewer, the first attempt made, even in Germany, to produce an encyclopedia of all the natural sciences, and must put all scientists, as well as all liberally educated laymen who can read German (and the contrary is a negation of terms) under great obligations to the house of Fischer, so well known among the great publishing houses of scientific works. It seems rather a pity that mathematics could not be included, because, although not a natural science, it is, if not the greatest of the sciences, at least the common tool and competent servant of all. Of course mathematics is taken care of in the great work named above, but that is no reason that it should not have been treated in a briefer and less technical way in a work of the scope of the present one, and its exclusion results in the inclusion of articles largely of a mathematical nature, such as the one on Flüssigkeitsbewegung, which appear in the mathematical encyclopedia by the nature of things, and also appear here as physical articles. In this connection the reviewer may perhaps be permitted to animadvert on the absurd classification of mathematics with philosophy, say in the group system at Harvard, which removes it from its closest friends and relatives, physics, astronomy and chemistry, and puts it along with an almost total stranger, and calls it to the attention of people most of whom are totally unable to use it. So much for logic, so little for common sense.

What most impresses the reader of the work under consideration is the great competence of the writers of the articles, and their absolute up-to-dateness. To be sure, some of the authors are decidedly young, but their articles are none the less good, and we must bear in mind the great number in Germany of brilliant minds among very young men, at least in physics. As an example of contemporaneousness we find in the extremely interesting article on Flüssigkeitsbewegung by Professor Prandtl, of Göttingen, mention of the most recent researches on fluid resistance, illustrated by a beautiful photograph of vortex-motion, involving work done only last year, while the famous principle of relativity, which was invented only in 1905, is treated in several articles, although not under a special heading. The articles on radioactivity and other radiations, those on Luftfahrt and Luftpumpe are further examples, the latter giving an excellent description of Gaede's new molecular air pump, a characteristically German invention,

which, like the *America* in the yacht race, is first, with no second.

This encyclopedia will fortunately not fill a five-foot shelf, but if we may judge from the present 46 parts, reaching Skelett, may go about to 60 and fill a little over two feet. According to German custom, it is issued unbound, and the parts do not appear in strict alphabetical order, which makes a slight difficulty in knowing at the present time exactly what it will contain. Nevertheless, the paging will be perfectly consecutive, and the piecemeal method of appearance has the advantage of permitting the articles to have the greatest possible freshness, and does not lead to the errors that sometimes crept into the "Britannica" from the immensity of the task of printing. The only possible comparison of the present work is with the "Britannica," which, although of general scope, contains scientific articles which are of the same general caliber as these. In both cases the articles are not popular, and are written by thoroughly competent writers, but at the same time they are interestingly written, and so clear as to be understood by the layman desiring to obtain exact knowledge. The present encyclopedia is issued at 2.50 Marks per part, so that if there shall be sixty, the cost of the whole will be less than forty dollars, exclusive of binding, a price that will make its ownership possible to many a scientific man to whom the "Britannica" at one hundred and twenty-five dollars would be an impossibility. The form of the page is also much more convenient than that of the "Britannica," and the volumes are less unwieldy. The print is as good, if not better, although decidedly different, the type being blacker and somewhat clearer, although not leaded, so that it is not easy to say which is the easier to read. The printing is, however, certainly as good, and the illustrations, at least in the opinion of the reviewer, are decidedly better, some of the biological illustrations being beautiful to look at, and even the physical ones being remarkably clear. The reviewer admits with pain that many of the cuts in the "Britannica" have to him a decidedly cheap look, which is never the case in the German work. These are photoengravings of a high quality of workmanship, and are used in great profusion. For instance, in the article Ei und Eibildung we find a thirty-three-page article profusely illustrated with beautiful and instructive cuts, while in the article Egg in the "Britannica" we find an article of three and a half pages, without a single picture. Undoubtedly the matter of the article is found somewhere else, but as a matter of fact the article on Embryology is similarly devoid of illustrations. Whether this is due to the smaller expense of printing illustrations in Germany we do not know, but the presence of the illustrations is a very desirable feature.

It is obviously impossible for any individual scientist to comment on all the sciences, so that the reviewer will confine himself to singling out a few articles on subjects with which he is familiar. The article on Elektrooptik is by Professor Voigt, of Göttingen, the chief authority on the subject, and the article on Lichtbogenentladung, a forty-page article on a new subject, by Professor Simon, of Göttingen, is a mine of information on that subject, with very attractive figures, reproductions of oscillograms by the author. All the electrical articles are well handled; we will mention only that on Elektrodynamik, by H. Scholl, which includes the treatment of all the theories from the classical ones down to the theory of relativity, in compact and clear statement, and that on Elektrische Masssysteme, by F. Emde, in which, beside a very clear treatment of the subject, we find a very ingenious graphical treatment by a diagram showing not only the dimensions, but also the relative magnitudes of the most important dynamical units. For the sake of comparison we will consider the articles on Elasticity in the "Britannica" and the present work in some detail. In the "Britannica" we have a nineteen-page article by Professor Love, of Oxford, the author of the leading treatise on the subject in any language, in which the leading equations of the theory are stated, with the chief practical results, without any great mathematical detail. In the German work we have an article of twenty-seven pages

by Dr. Th. v. Kármán, who, although a very young man, has no need to apologize for his article, which, although containing fewer formulæ, is written with great clearness and has even better cuts than the English article. To be sure Dr. Kármán had the advantage of reading Professor Love's article as well as his great treatise, but the article is decidedly independent, and concludes with an excellent treatment of elastic hysteresis or Nachwirkung, which is becoming more and more important, and which we do not find mentioned in Professor Love's article. Very likely this is also due to the more recent appearance of the German work. For the biologist we will mention the fifty-three-page article on Descendenztheorie, profusely illustrated, as compared with the "Britannica" article on Evolution, of fifteen pages, without illustrations.

A feature of the present work that is of great importance is found in the biographical sketches, which, although very short, are decidedly helpful. We have looked in vain for the name of Mendel, but find three generations of Becquerels. It is a pleasure to note throughout the work frequent references to the work of Americans, living and dead, of whom we may mention Rowland, Newcomb, Michelson, R. W. Wood, Campbell, E. B. Wilson and W. M. Davis, whose familiar hand is recognized in the admirable drawing of meanderings in the article Fluss. This fact, which is now becoming more and more general, may partially reconcile us to the state of affairs upon which we have commented at the beginning. It may seem premature to review a work that is not yet finished, but it seems of importance to call the attention of the public to this very important and desirable work.

ARTHUR GORDON WEBSTER

July 26, 1913

Studien an intracellularen Symbionten. I. Die intracellularen Symbionten der Hemipteren. By DR. PHIL. PAUL BUCHNER, Privatdocent in the University of Munich. Reprinted from "Archiv für Protistenkunde," Vol 26. Jena, 1912. Pp. 116, 12 plates and 29 text figures.

For many years students of insect morphology and embryology have noted in the fat body of larval and adult insects and in certain eggs and embryos, peculiar corpuscle- or rod-like bodies, seemingly extraneous in origin and whose nature and function could not be satisfactorily explained.

Thus, as far back as 1850, Leydig observed the appearance, in embryos of viviparous aphids, of "a green or yellow granular mass which at first apparently lay free between the cells, but later massed in spherical form, became enclosed by a membrane, and took part in the formation of the vegetative organs of the insect." This constituted the mass later designated by Huxley and by Lubbock as the "pseudovitellus," a name very generally accepted by embryologists, though some have regarded the mass as having a very specific function. According to Babiani, who demonstrated its origin within an enlarged cell of the follicular epithelium, it represents the vestigial male sex gland of the agamic individual. On the other hand, Witlaczil regarded it in the form of the "green body" of the adult aphid, as an excretory organ, replacing the Malpighian tubes which are lacking in some species.

Of less striking appearance are the bacteroidal bodies found by Blochmann, '84, in the eggs of certain ants and, later, studied more fully by him in the eggs and adult fat body of *Blatta* and *Periplaneta*. These little bodies, which Wheeler, '89, called Blochmann's corpuscles, have also been found in the larval fat cells of *Pieris* and in various orthoptera. They are in the form of minute, straight or slightly bent rods, 6–8 μ long and, as Blochmann was able to determine, multiply by cross division. He was unable to cultivate them, but regarded them as symbiotic bacteria.

In recent years there has accumulated evidence to show that these scattered structures are related and that Blochmann was right in interpreting them as symbiotic forms. Many such suggestions appear in the literature of the past fifteen or twenty years, but it is especially the work of Mercier (1906), Sulc (1906

and '10), of Pierantoni (1909 and '10), who succeeded in isolating and growing certain forms in pure culture, that has furnished the basis for a correct interpretation and for a comprehensive study of these bodies in the various groups of insects.

Such a study has been commenced by Dr. Buchner and the extensive paper before us considers primarily the intracellular symbionts of the hemiptera. There is a very full historical discussion which will be of great value to other students of the general subject, and which will serve to put the reader, be he botanist or zoologist, *en rapport* with the topic. Then follows a detailed discussion of the author's own investigations.

Of special interest are the data on the method of infection of the developing eggs by the organisms. This may take place in a diffuse manner, as in the cockroaches, or it may be very definitely localized, as in the aphids. In any event, we are concerned with a hereditary transmission of bacteria-like or yeast-like organisms.

Concerning the systematic position of the forms studied there is little definite to be said, though it is certain that the intracellular symbionts of insects, as we know them at present, do not represent a closely definable group. The forms in the cockroaches are apparently true bacteria and probably so also are those of the ants.

On the other hand, the multiplication by budding, the type of mycelial formation, the lack of structures comparable to spore of bacteria, the constant presence of a nucleus, and other characters in the other forms studied are suggestive of the yeasts, and it is here that most of the recent students of the subject are inclined to place them. Thirty-four species, some of them new, loosely grouped here, are described and figured.

It is obvious from Buchner's studies that these puzzling organisms are not to be regarded as parasites. So striking are some of the specializations and adaptations which their presence has brought about, that it is equally impossible to regard them as mere commensals. But certain as the author is that he is dealing with true symbionts, he is unable to explain, satisfactorily, the advantage which accrues to the host.

Dr. Buchner's work is of fundamental importance, but one must agree with him that it is but a beginning. With the foundation work done, the next few years should see wonderful advance in our knowledge of this difficult subject.

Wm. A. Riley
Cornell University

BOTANICAL NOTES

SOME STATISTICS AS TO THE FLOWERING PLANTS

In this inquiry I have considered only the proper Flowering Plants, Anthophyta or "Angiospermae," and have given most of the numbers in thousands, for easier memorizing.

Number of species of Flowering Plants	±132,500
Dicotyledons	±108,800
Monocotyledons	± 23,700
In the Dicotyledons:	
Axiflorae	± 54,000
Calyciflorae	± 54,000
In these again:	
Axiflorae—apopetalae	± 29,000
Axiflorae—gamopetalae	± 25,000
Calyciflorae—apopetalae	± 33,000
Calyciflorae—gamopetalae	± 21,000
So there are:	
Of Apopetalous Dicotyledons	± 62,000
Of Gamopetalous Dicotyledons	± 46,000
Again, there are in Dicotyledons:	
Ovaries, superior	± 72,000
Ovaries, inferior	± 36,000
Those with superior ovaries are distributed as follows:	
In Apopetalous species	± 50,000
In Gamopetalous species	± 22,000
Those with inferior ovaries are distributed as follows:	
In Apopetalous species	± 14,000
In Gamopetalous species	± 22,000
In the Monocotyledons:	
With ovaries superior	± 12,000
With ovaries inferior	± 11,000
In Monocotyledons gamopetaly has not become established.	
So there are in the Flowering Plants:	
Of Apopetalous species	± 86,000
Of Gamopetalous species	± 46,000

And again there are:

With superior ovaries	± 84,000
With inferior ovaries	± 48,000

TWO BOOKS ON TREES

FROM the botanical garden and arboretum of the University of Michigan we have a little book of somewhat more than two hundred and seventy-five pages entitled "Michigan Trees: A Handbook of the Native and Most Important Introduced Species," by Charles H. Otis, curator. In its preparation the author has aimed to produce a book that would stimulate interest in the study of trees, having ultimately in view the betterment of forest conditions in the state. By means of keys ("summer" and "winter"), good pictures and clear descriptions it is made possible for any one of ordinary intelligence to find out what is the name and general relationship of any of the trees commonly found in Michigan. In order that it may be widely distributed the regents of the university have arranged to send one copy of the book free to every legal high school in the state, to every public library, nature study club, and finally to every resident of the state "who desires it." Surely the residents of Michigan, old and young, have no excuse hereafter for not knowing the trees growing about them.

The second book is Monograph 8, of the Geological Survey of Alabama, and is Part 1 of the "Economic Botany of Alabama," by Roland M. Harper, this part being devoted to the forests of the state (228 pp.). The book opens with a map of the state, in colors, showing geographical and forest regions. Starting with the remark that "Alabama has probably been more thoroughly explored by various kinds of scientists than has any other southern state," the author gives first of all a bibliography of Alabama forestry, and follows it with chapters on the natural regions, as the Tennessee Valley, Coal Region, Coosa Valley, Blue Ridge, Piedmont Region, Central Pine Belt, Black Belt, Southwestern Pine Hills, etc. In each region after geographical, geological and climatic details lists of trees are given, followed by a discussion of certain economic aspects. Then follow many half-tone reproductions of photographs of forests and forest matters. An interesting feature of these illustrations is that the exact dates when the photographs were taken are given. An unusually full index closes the report.

SOUTHERN SYSTEMATIC BOTANY

TEN years ago Dr. John K. Small, head curator of the museum and herbarium of the New York Botanical Garden, brought out his "Flora of the Southeastern United States," covering the region south of the southern line of Virginia, Kentucky, Missouri and Kansas, and east of the 100th meridian. The book has proved so useful that the author has been encouraged to bring out a second edition. This has been done by the rewriting of 144 pages, and the addition of 53 pages of descriptions of additional species in the appendix, making nearly 200 pages of new matter in the whole book. Since the book contains about 1,400 pages the amount of revision is easily made out.

The same author's "Flora of Miami" (206 pp.) contains descriptions of the native gymnosperms and angiosperms of southern Florida. In looking it through one is as much struck by the absence of certain well-known genera as by the presence of others which are quite unfamiliar. Thus *Carex* is unrepresented, as are also *Ulmus, Populus, Brassica, Taraxacum, Rosaceae, Malaceae*, etc., while of *Ranunculaceae* there is but one species; *Salix*, one species; Mints, eight species; *Helianthus*, one species. Florida tourists should have this handy little book for use in the southern part of the state.

A third book by Dr. Small will also be of interest to Florida tourists. It bears the title "Florida Trees" (107 pp.) and is intended to be a handbook of the native and naturalized trees of the state. When we realize that "nearly one half of the trees known to occur naturally in North America north of Mexico and the West Indies grow naturally in the relatively small area of the state of Florida" the importance of this little book may be appreciated. By actual count there

are here included 365 species. Of these 15 species are gymnosperms; 10, palms; 23, oaks; with 48 species of *Crataegus*.

These three books are published by the author.

SHORT NOTES

A NEW edition of the "Guide to the Spring Flowers of Minnesota" (by Clements, Rosendahl and Butters) has just appeared, so broadened and extended as to include the plants that ordinarily blossom by the middle of June. Small but helpful figures of about 160 genera are now given in the text. The plan of these "Guides," of which half a dozen have been published, is to be highly commended.

ANNOUNCEMENT is made of the early appearance of a book on "Rocky Mountain Flowers," by F. E. and E. S. Clements. It is to be "an illustrated guide for plant-lovers and plant users" and is to contain twenty-five colored plates, and about as many uncolored. An examination of some of the colored plates indicates that they will be highly artistic as well as botanically accurate. The volume is bound to be one that will appeal strongly to those who "summer" in the Rocky Mountains.

CHARLES E. BESSEY

THE UNIVERSITY OF NEBRASKA

SPECIAL ARTICLES

THE APPLICABILITY OF THE PHOTOCHEMICAL ENERGY-LAW TO LIGHT REACTIONS IN ANIMALS

IT has been pointed out by Loeb that tropistic light reactions in animals should follow the law of Bunsen and Roscoe. This law states that in a light reaction the effect is proportional to the simple product of intensity and time. It was first proved to be true for the formation of hydrochloric acid from chlorine and hydrogen and for the blackening of silver chloride under the influence of light. Later it was found to apply to the phototropic curvature (Fröschel, Blaauw) of plants, as well as to the human eye, though within rather narrow limits (Bloch, Charpentier). For light reactions in animals it has frequently been stated that they do not follow this simple law. A large number of forms seem to react to changes of intensity only, the effect in this case being proportional to the amount of change per unit of time. This is particularly true of the stimulating and inhibitory reflexes of the locomotor apparatus, as shown by a large number of investigators.

It occurred to me that it might be possible to get proof for the applicability of the energy-law by using a reaction which did not involve the locomotor organs. The eye movements of *Daphnia* seemed to afford a suitable object for the study of this question. These movements were first observed by Radl and his observations were confirmed and extended by myself some years later. The spherical eyeball containing a number of radially arranged ocelli is capable of rotation and held in position by several thin muscles inserted at its periphery. The eye shows a definite normal position with regard to light, a certain axis of the sphere having to be placed in such a direction that the ocelli on all sides of this axis get an equal amount of illumination. The muscles keep the eye in this position and one can cause rotating movements of the eyeball, by shifting the position either of the source of light or of the animal. The eye will always maintain its fixed position to the source of light, no matter whether the body of the animal follows the eye or not. An unequal state of tension of the eye muscles seems to cause locomotor movements, which tend to restore the normal relative position of eye and body. By fixing the animal on a slide it can be prevented from moving and the eye movements may be observed at leisure. Instead of shifting the position of the light the eye can be placed in a position of equilibrium between two sources of light and eye movements can be caused by increasing or decreasing the intensity of either of them. This shows these movements to be a function of the intensity of illumination.

In order to test the energy law, it is necessary to combine different light intensities with different times of exposure. If the product of time and intensity, *i. e.*, the amount of radiant energy brought to bear on the eye, is the same, the eye will always give the same

reaction. To this end I proceeded in the following manner. The animal was fixed in a definite position on the stage of a microscope, illuminated from below by a weak electric light of constant intensity. The microscope stood in a blackened dark-room. Through a hole in the wall of the room the light of an 80 candle-power Tungsten lamp fastened outside could enter. The light was made diffuse by a sheet of oiled paper fixed across the opening. The hole was 55 mm. in diameter and was closed by a piece of cardboard containing two diaphragms of varying sizes, side by side. A shutter with a spring motion could alternately close either the one or the other opening. I could thus make an instantaneous change from a stronger to a weaker light, and *vice versa,* by using diaphragms of different sizes and moving the shutter to and fro. One diaphragm was maintained at constant size (25 mm. diameter) and a sector wheel or episcotister, driven by a small electromotor, could be rotated before it. The light passing this diaphragm had an intensity of 0.9 c.p. The distance between the animal and the diaphragm was about 60 cm. Obviously, if two diaphragms were used whose areas were as 1:10 and a sector wheel with 1/10 of the periphery cut out were rotated before the larger one, so as to let light pass during 1/10 of a revolution, then equal amounts of radiant energy would reach the eye of the animal through either diaphragm.

The microscope was placed in such a position that the light from the diaphragms could fall on the stage from the side. If the smaller diaphragm was opened, the eye of the *Daphnia* took up a position, defined by the ratio of intensities of the light coming from the weak lamp below and from the diaphragm above. Changing from the smaller to the larger diaphragm would cause a change in the position of the eye. By varying the sizes of the diaphragms I found that a noticeable reaction was obtained upon changing from one diaphragm to the other, even when the difference between their areas was as small as 10 per cent. Change between diaphragms of equal size, however, did not produce a reaction.

Using the diaphragm ratios 5:10, 2.5:10 and 1:10 I invariably found that upon using a sector wheel cutting down the time of exposure for the larger diaphragm so as to make the amount of energy equal to the smaller one, I obtained *no reaction* on change from one to the other. If I used sector wheels giving too long or too short exposures, a reaction was noticed, where the error exceeded 10 per cent. *These observations prove that for the eye movements of Daphnia the energy law holds within the limits of accuracy characteristic of the reaction.* The speed of the sector wheel in these experiments was about 1/30 of a second for one revolution. If slower speeds were used, marked deviations from the law began to appear, the intermittent having a weaker effect than the constant light. In some cases I got a marked reaction of the eye on change from constant to intermittent light of equal energy when the speed of the sector wheel was about 1/10 of a second per revolution. The deviation becomes more marked, the slower the speed. The explanation for this phenomenon will be dwelt upon in a subsequent paper.

Strictly speaking, the law proved by my experiments is not the Bunsen-Roscoe law, but the law discovered more than twenty years earlier (1834) by Talbot, which states that the effect of intermittent light equals that of a constant light, if it emits the same amount of energy through a given period. In our case it means practically the same as Bunsen-Roscoe's law, each revolution of the sector wheel constituting one period, in which there is a given relation between intensity and duration of the light flash and a definite time for reaction. The variously arranged sector wheels provide the possibility of testing different ratios. The constant light coming from the smaller diaphragm is used in such a way as to serve as a measure or standard of comparison and circumvent the necessity of determining a threshold of stimulation.

Wolfgang F. Ewald

The Rockefeller Institute,
Department of Biology,
July 14, 1913

THE IOWA ACADEMY OF SCIENCE

The twenty-seventh annual meeting of the academy was held in Alumni Hall, Iowa State College, Ames, beginning at 1:30 P.M., Friday, April 25.

President Pearson, of the Iowa State College, extended a welcome to the academy at 8:00 P.M., Friday. After this the public address on "Wealth from Worthlessness" was given by Dr. Thomas J. Burrill, professor emeritus of botany, University of Illinois.

PROGRAM

(Abstracts are by the authors)

Tramping about Puget Sound: T. H. MacBride.

Pure Lines and What they Mean to Iowa's Grain Crop: L. C. Burnett.

The Physiology of the Pollen of Trifolium pratense: J. N. Martin.

The Comparative Morphology of the Legumes: J. N. Martin.

A Preliminary List of the Parasitic Fungi of Boone County, Iowa: H. S. Coe.

A Partial List of the Parasitic Fungi of Decatur County, Iowa: J. P. Anderson.

The Pollution of Underground Waters with Sewage through Fissures in Rocks: Henry Albert.

The possibility of pollution of underground waters through fissures in rocks has long been a well-established fact. The actual demonstration of such as the source of cases or epidemics of disease in Iowa has until recently not been proved. The more superficial rocks of the state present many joints or fissures. Although the epidemic of typhoid fever in Cedar Falls during 1911 was believed at that time to have occurred as a result of the pollution of waters through fissures in rocks, it is believed now that pollution occurred through a wooden conduit which conducted the water from the spring to the pumping station. The best example that we have of an epidemic no doubt traceable to pollution through fissures in rocks is the epidemic of typhoid fever which occurred at Fort Dodge during the summer and fall of 1912, during which about one hundred persons were affected by the disease. The water supply of Fort Dodge comes principally from the deep wells. They also take the water from pipes beneath the river. The source of infection was apparently both from the pipes beneath the river and from one of the deep wells. The feature of interest is in connection with the latter. This well (well No. 1), which was the first of the three wells as also the deepest one—being 1,827½ feet deep and extending to the Jordan sandstone—was started at the bottom of a large shaft which was constructed several years previously for the purpose of supplying the city with water. This shaft, which measures 10 × 10 feet across, extends down for 90 feet. From the west side of the lower end of this shaft a tunnel of 9 feet in diameter was extended under the Des Moines River. This tunnel was driven in sandstone, so required but few timbers for support, whereas the shaft has a wooden casing for almost its entire extent. The shaft extends successively from above downward through the following layers of earth:

Alluvial soil and clay	31 feet
Limestone	6 feet
Shale, blue	27 feet
Limestone	6 feet
Sandstone	42 feet[1]

There are only about 20 feet of gravel, alluvial soil and clay from the bottom of the river to the first layer of limestone. Through this the water from the river and surrounding soil will probably pass quite readily and without efficient filtration. It then comes to a layer of limestone which is known to contain many fissures, through which water may readily enter the shaft. Beneath the limestone is a layer of blue shale, 27 feet in thickness. This is relatively impermeable to water, hence tends to keep the water from passing directly downward and so hastens the passage of water laterally along the limestone fissures—in the direction of least resistance—namely, toward the shaft. Previous to the construction of the tunnel the seepage into the shaft was at the rate of about 55 gallons per minute. This was increased to 80 gallons per minute by the construction of the tunnel. This would seem to indicate that the water which enters the shaft is of recent surface origin. That the water must have come principally through such fissures in the rocks is indicated by the fact that when the shaft was constructed but little water appeared until after the limestone layer with its fissures had been entered. That the water which comes from the shaft is polluted with sewage material has been shown repeatedly by clinical and bacteriological examinations. When the first artesian well was drilled (well No. 1) it was started from the bottom of the above-mentioned shaft. The casing of this well extends through the shaft and projects at the

[1] Tunnel in this formation.

top several feet above the level of the water in the shaft. The water flowing from the artesian well fell into the shaft which became filled with water to the top of the discharge pipe. In this manner the water from the artesian well and the seepage water from the shaft and tunnel were mixed. Soon after the completion of this artesian well a sample of this water was sent to us for examination. We expected to find either no bacteria or only a very few. We found, however, that the bacterial count went up to 42 per cubic centimeter with two colonies of colon bacilli. Chemical examination likewise showed evidence of contamination with sewage material. The reason for this was not explained until after a personal inspection and subsequent examination showed that the contamination occurred in the large shaft with water from the shaft and tunnel. The water taken directly from the well did not show any evidence of pollution. We believe that the water of the tunnel and shaft comes largely quite directly from the river through fissures in the rocks and hence is not properly filtered.

Bacterial Activities and Crop Production: P. E. BROWN.

The importance of soil bacteria in bringing about the change of insoluble material containing the essential plant food constituents into forms which are available for the feeding of crops is emphasized as a basis for the assumption that there should be some relation between essential bacterial activities and actual crop production. Determinations of total numbers of organisms using an albumen agar and estimations by the beaker method of the ammonifying power and the nitrifying power of the soils of several series of field plots were made. Comparison of the results of these bacteriological studies with the actual crop yield revealed the fact that in practically every case a soil showing greater numbers of organisms, greater ammonifying power and greater nitrifying power than another soil showed likewise greater crop production. Fresh soil with a solution of casein added for ammonification and a solution of ammonium sulfate added for nitrification allowed of the greatest differentiation according to bacterial activities of the soils tested.

The Monterey Conifers: THOMAS H. MACBRIDE.

A discussion of the distribution and habits of the four conifers, *Cupressus macrocarpa* Hartweg, *Cupressus Goveniana* Don, *Pinus muricata* Don and *Pinus radiata* Don, which are found in the vicinity of Monterey, California.

Quercus borealis Michx. f.: B. SHIMEK.

This is generally regarded as a synonym of *Q. rubra,* but it seems to be quite distinct. The paper contains a discussion of its characters and its distribution in Iowa.

The Sedges of Henry County: JOHN THEODORE BUCHOLZ.

A discussion of the physiography and topography of Henry County with special reference to the distribution and habitats of the sedges, followed by an annotated list of the species found in Henry County.

The Diclinous Flowers of Iva xanthiifolia Nutt.: CLIFFORD H. FARR.

The placing of this species among the Compositæ is favored by the fact that the walls of adjacent stamens unite by the fusion of contiguous cutinized layers. Furthermore, the flowers are arranged in a capitulum in concentric cycles of five flowers each. The outer cycle consists solely of pistillate flowers, and the remaining cycles are made up entirely of staminate flowers. The abortive stamens of the pistillate flower appear after the carpels, and were seen occasionally to have developed into pollen-bearing members. It is evident that the stamens of the marginal flowers, being epigynous, would come in contact with the enlarged ends of the corollas of adjacent staminate flowers and with the apices of the floral and involucral bracts. That this crowding may have caused the abortion of these stamens seems credible. The abortive pistil of the staminate flower doubtless aids in dehiscence by engaging the hook-like tips of the stamens. It possesses no ovary, but early develops a notch on its apex, which suggests its derivation from the typical bifid form. The gynœcium of a flower is more susceptible, both in structure and in function, to the effects of desiccation than is the andrœcium. The central flowers of this form are more exposed than the marginal on account of the following circumstances: their distance from the involucral bracts, their tardy appearance, the minuteness or absence of floral bracts of the disc flowers, the convexity of the receptacle, and the remoteness of the disc flowers from the main vascular supply. It therefore seems that exposure to desiccation through many generations will explain the abortion of the pistil in the disc flowers. Excessive exposure of certain flowers and excessive protection of others are therefore suggested as the major causes for the origin of decline in this species.

The Effect of Smoke and Gases upon Vegetation: A. L. Bakke.

Industrial centers have succeeded in having associated with them a large quantity of smoke. Under ordinary conditions the amount of smoke decreases with the increase of the distance from the business center. In making a study of two smoke districts of Chicago it has been found possible to use plants as an index to the amount of smoke present.

Aroid Notes: James Ellis Gow.

The taxonomy of a number of species of Aroids, chiefly tropical, has been worked out and is here presented for the first time.

Phylogeny of the Monocotyledones: James Ellis Gow.

Researches on the morphology of the Aroids, with special reference to the phylogeny of the group, have led the author to question the theory as to the primitive character of the monocotyledonous plants; and he here defends the view that the most primitive forms are to be found among the spiral Dicotyledones.

The Grasses of the Uintah Mountains and Adjacent Regions: L. H. Pammel.

Brief account of grasses collected in the Uintah Mountains and the adjacent regions based on collections made by the writer during several seasons in which the flora of the region was studied. The paper records the habitats, distribution and abundance of the species.

Notes on the Flora of Johnson County, Iowa: M. P. Somes.

An annotated list of plants observed growing in Johnson County, Iowa, comprising 1,008 species, representing 413 genera, included in 101 families. Not including mosses, fungi or the other cryptogams lower than the ferns.

The Electrical Conductivity of Solutions of Electrolytes in Aniline: J. N. Pearce.

Equilibrium in the System; Cobalt Chloride-pyridine: J. N. Pearce and Thomas E. Moore.

The Osmosis of Optical Isomeres: A. R. Johnson.

Observation on the Specific Heat of Milk and Cream: Johnson and Hammer.

A New Design for Specific Apparatus: Johnson and Hammer.

A Proposed Method for Determining the Ratio of Congealed to Uncongealed Water in Frozen Soil: Johnson and Ray Smith.

Factors in Milk Production: Frank B. Hills.

By a microscopical examination of many samples of milk of different fat composition percentages, numerous counts were made of the numbers of fat globules of different sizes. A positive relation was found to exist between the percentage fat composition of the milk and the numbers of globules of different sizes, the correlation coefficient being .19. A study of the tabulated fat records of about 3,700 pairs of variates, taken from the Advanced Register Year Book of the Holstein Friesian Association, showed by a correlation coefficient of .29, evidence of so-called prepotency of dams in the transmission of fat production to their daughters. This would indicate a probable sex linkage of some of the factors in the inheritance of fat production. A rearrangement of the data into groups for the study of the fat production of three consecutive generations of animals showed segregation of fat factors in a 7:1 ratio, giving further evidence of linkage of some of the factors in the inheritance of fat content in milk.

Nitrogen and Chlorine in Rain and Snow: Nicholas Knight.

Twenty-six specimens of rain and snow were carefully collected during the year 1911–12, and the amount of nitrogen in the nitrites, nitrates, free and albuminoid ammonia estimated. The amount of nitrogen that an acre of land received from each precipitation was computed. Chlorine was found in each specimen in which it was sought. This must come from the oceans as common salt.

Exhibition of Barograph and Thermograph Tracings of the Omaha Tornado: John L. Tilton.

The Limestone Sinks of Floyd County, Iowa: A. O. Thomas.

Notes on the Nebraskan Drift of the Little Sioux Valley in Cherokee County: J. E. Carman.

The Wisconsin Drift-plain in the Region about Sioux Falls, South Dakota: J. E. Carman.

Some Additional Evidence of Post-Kansan Drift near Iowa City, Johnson County, Iowa: Morris M. Leighton.

The Rock from Solomon's Quarries: Nicholas Knight.

A specimen of what is locally known as the "Royal" was received from Jerusalem for analysis. It was of the purest white, soft when first removed from the quarry, but it soon hardens on exposure to the air. The rock is very pure calcium carbonate, with little more than a trace of magnesium carbonate.

Iowan Cretacic Sequence: CHARLES KEYES.

Deposits homotaxially equivalent to the Cretacic, or Chalk, formation of England were first recognized on the American continent along the Big Sioux River in a district which is now incorporated in the state of Iowa. This correlation was almost the first attempt to apply the fossil criteria to the rocks of this country. Less than a decade had elapsed since this means had been formulated by William Smith in England. The use of the method was introduced in 1809 by Thomas Nuttall, an English botanist who during the following year ascended the Missouri River from St. Louis. Notwithstanding the fact that this region was visited repeatedly during a whole century which has elapsed since Nuttall's visit, it has been only within the last year that the complete Cretacic section in Iowa has been with certainty determined. The total thickness of the beds is now known to be not less than 800 feet. It is separable into seven distinct terranes. These are defined as the Nishnabotna sandstones, the Sergeant shales, the Ponca sandstone, the Woodbury shales, the Crill limestone, the Hawarden shales and the Niobrara limestones.

Terranal Differentiation of Devonic Succession in Iowa: CHARLES KEYES.

Upon faunal grounds, as well as for lithological and stratigraphical reasons, the main Devonic limestones of Iowa, or the Cedar Valley formation as they are most widely known, were found more than a score of years ago to be separable into five well-defined terranes. No special geographic names were attached to these several subdivisions. They are, however, commonly recognized as valid by all who have studied the field in detail during the term of years mentioned. Calvin published the general section with these division-lines indicated but he gave no distinctive local designations. The terranes are easily distinguishable over wide areas. For the lower number the title Fayette formation is retained. The others are called the Solon, Rapid, Coralville and Lucas formations. The subdivisions are briefly characterized.

Possible Occurrence of Tertiary Deposits East of the Missouri River: CHARLES KEYES.

Deposits of Tertiary age have never been recognized as occurring within the limits of Iowa. Their presence, however, has long been surmised. The repeated invasions of glaciers have naturally removed nearly all vestiges of any soft rocks which may have existed in pre-glacial times upon the older indurated strata.

The majority of such remnantal deposits are easily mistaken for phenomena connected with the glacial drift-sheets. Yet there are several of these sections along the Big Sioux River, for instance, the beds of which appear not to be of glacial origin. They seem to belong to isolated patches of the Tertiaries which are fully represented in the eastern parts of South Dakota and Nebraska. One pocket in particular, exposed near Sioux City, and called the Riverside sands, now appears to be unquestionably Tertiary in age.

Wright's "Ice Age" on the Genesis of Loess: B. SHIMEK.

In the second edition of Wright's "Ice Age" objections are made to the æolian hypothesis of loess origin. This paper aims to meet these objections, and sustains the æolian hypothesis.

Preliminary Note on the So-called Loess of Southwestern Iowa: JAMES ELLIS GOW.

This is a discussion of the nature and origin of a clay found in Adair County at the surface of the drift. It contains no gravel or bowlders and in near-by localities has been described as "loess." Investigation shows that it is neither aqueous nor æolian in origin and that it may occur in the Kansan drift at any and all depths.

The Proper Use of the Geological Name, Bethany: JOHN L. TILTON.

The term Bethany Falls limestone, or Bethany limestone, has been used with three different meanings. It properly applies to the second limestone of the section found at Winterset, which limestone is called the Earlham.

A Pleistocene Section from Des Moines South to Allerton: JOHN L. TILTON.

Along the new railroad line from Des Moines to Allerton are fine exposures of the Pleistocene, photographs and descriptions of which should be preserved for reference since the relation of the deposits will very quickly become obscured. The exposures present strong evidence, supported elsewhere, that the so-called "gumbo" was deposited in the closing stages of the Kansan, and that it is but one form of a deposit for which collectively the term Dallas deposits is here suggested. Kansan drift and Des Moines shales are well exposed, but no Aftonian nor Nebraskan. Loess is found only in the northern portion of the area.

Mound and Mound Explorations in Allamakee County, Iowa: ELLISON ORR.

The paper covers in a general way the pre-

historic earthworks found in this country along the Mississippi and Oneota rivers. These earthworks consist of three types, the most common being the Circular Mound. Following that the Long Embankment, these latter sometimes having a length of upwards of four hundred feet, and where found on the bluff tops they uniformly follow the divides separating the gullies and ravines opening into the main river valley. Following these in frequency of occurrence are the Effigy Mounds. It is somewhat difficult to say what particular animal or bird these mounds are intended to represent, but there is quite a variety. Near McGregor is a group of three which are in a very fine state of preservation and were undoubtedly intended to represent the buffalo. Along the Oneota River, but not found on the Mississippi, are embankments in the form of a circle. Some of these are on the bluff tops and some on the river bottoms. It is more than likely that a part of them are the remains of camps fortified with palisades, and others may have been built for some ceremonial purpose. The circular mounds are probably mostly burial mounds, and probably of great age, as no skeletal remains are found in any of them, and there is also a great scarcity of flint or other implements or of pottery.

An Electrical Method of Measuring Certain Small Distances, and Some Interesting Results: F. C. Brown.

The Variation of the Resistance of Antimonite Cells with the Current Flowing, and the Probable Interpretation of this Variation: F. C. Brown.

The Change of Young's Modulus of a Soft Steel Wire with Electric Current and External Heating: H. L. Dodge.

Are the Photo-electric High Potentials Genuine: Paul H. Dike and F. R. York.

Some Dangers in Statistical Methods: Arthur G. Smith.

The Problem of the Vision of an Illuminated Surface: L. P. Sieg.

On the Existence of a Minimum Volume Solution: LeRoy D. Weld.

Phase Relations and Sound Beats when the Tones are Presented One to Each Ear: G. W. Stewart.

It has long been known that beats produced by two tones, presented one to each ear, are not quite like the beats produced when the same tones are presented to one of the ears. The experimental arrangement in this experiment was such that the frequency of beats could be changed, the tones being presented one to each ear, and the difference of phase could be observed optically. The observed results were as follows: When the beats were more frequent than one per second the beats were similar to ordinary beats except that there was no zero intensity minimum. This fact is not new. When the beats became less frequent than one per second, it was possible to persuade the hearer that there was a secondary maximum in the neighborhood of opposition in phase. When the beats became less frequent than one each five seconds the maximum intensity is difficult to select, the secondary maximum being more pronounced. Further, the secondary maximum seems to consist of two maxima, one just before and one just after opposition of phase. The tone at equality of phase is different in quality to that at the secondary maxima, the former being like the tone of the fork and the latter more of a noise. Some observers can not get the effect at all. When one of the tones is received through the teeth with the other received at one of the ears, there appears to be only one maximum, and that at opposition of phase. The proposed explanation involves a combination of a skull tone and an ear tone; but is too complicated to present in an abstract. The theory agrees with the experiments in a quantitative way if the velocity of sound in the skull is from two to three times that in air. The presence of a maximum at equality of phase does not seem to permit of ready explanation if the possibility of interference beyond the cochlea is rejected. The experiments were with forks of frequency 128. The theory should be tested under varying conditions.

The Use of the Rayleigh Disk in the Determination of Relative Sound Intensities: Harold Stiles.

During the summer of 1912 some experimental work was done at the State University of Iowa by G. W. Stewart and Harold Stiles partly intended to test the Rayleigh disk in the determination of relative sound intensities. The apparatus was mounted on the roof of the new physics building and results obtained experimentally were in close agreement with the theoretical values obtained by Stewart[3] for sound intensities in the neighborhood of a rigid sphere, the source of sound being on the sphere. Air currents, the inconstancy of the sound source and more particularly the absorption of energy by the Rayleigh

[3] *Phys. Rev.*, Vol. XXXVIII., No. 6, December, 1911.

disk tube are difficulties in the use of the apparatus.

A more extended account of the work may be found in *The Physical Review*, Vol. I., No. 4, 2d series, April, 1913.

An Experimental Investigation of the Relation between the Aperture of a Telescope and the Quality of the Image Obtained by It: Fred Vorhies.

Through research work carried on at the State University of Iowa, the conclusion has been drawn that astronomers are able to detect certain details upon the planet Mars. A twenty-four-inch telescope, as used by Professor Lowell, seems to be capable of giving these details as distinctly as can be obtained with a telescope of larger aperture.

Helpful and Harmful Iowa Birds: Fred Bern-inghausen.

The Food Habits of the Skunk: Frank C. Pellett.

A Further Study of the Home Life of the Brown Thrasher, Toxostoma rufens (Linn.): Ira N. Gabrielson.

The paper is a summary of the data obtained by watching from a blind the feeding of the young throughout one day. The total number of feedings was 169, of which 85 were by the male and 84 by the female. The following figures show the percentages of the various insects, etc., which comprised the food. Grasshoppers, 17.51 per cent.; May beetles, 29.95 per cent.; cutworms, 13.36 per cent.; cherries, 8.75 per cent. Miscellaneous insects made up the remainder. From the data at hand it seems that the thrashers are decidedly beneficial.

Nest Boxes for Woodpeckers: Frank C. Pellett.

A review of three years' successful experiments in attracting birds that supply no nesting material to artificial nesting sites. Three species not heretofore known to occupy boxes have reared their families in boxes of special pattern.

On Certain Features in the Anatomy of Siren lacertina: H. W. Norris.

Apropos of conflicting statements as to the presence of a maxilla and an operculare (splenial) in the skull of *Siren* the writer finds both present, but in a much reduced condition. Connected with the antorbital cartilage are two muscles (mm. retractor et levator antorbitalis) which with the cartilage form an apparatus for regulating the size of the choana. These two muscles have their homologues in *Amphiuma*. The ramus palatinus posterior facialis innervates a small vestigial muscle that has its origin on the fascia between the quadrate cartilage and the lateral edge of the parasphenoid bone, and its insertion on the lateral border of the ceratohyal cartilage.

Life History Notes on the Plum curculio in Iowa: R. L. Webster.

A summary of insectary notes on the insect made in 1910 at Ames. These, taken with some field observations made by C. P. Gillette at Ames in 1889, give a fairly accurate account of the seasonal history of the insect in central Iowa.

Additional Mammal Notes: T. Van Hyning.

The following species to the faunal list of Iowa have been added:

Firmly established: Canada porcupine, *Erethizon dorsatus* Linn.; Lemming mouse, Cooper's mouse, *Synaptomys cooperi* Baird; western harvest mouse, *Reithrodonomys dychei* Allen; pekan, fisher, *Mustella permantii* Erxleben. Now living in the state: American otter, *Lutra canadensis* Screber; American badger, *Taxidea americana* Boddaert; Canada lynx, *Lynx canadensis* Guldenstadt; American panther, cougar, puma, mountain lion, *Felis concolor* Linn. Additional to the catalogue: chickoree, small red squirrel, *Sciurus hudsonicus* Pallas; star-nosed mole, *Condylus cristata.*

The following have been listed for Iowa in *Bull. Field Col. Mus. Zool. Sur.*, Vol. 1, and may be looked for: *Peromyscus michiganensis* Audubon and Bachman, wood mouse; *Peromyscus leucopus* Rafinesque, wood mouse; *Tamias quadrivittatus neglectus* Allen, chipmunk; *Scalops argentatus* Audubon and Bachman, mole.

Color Inheritance in the Horse: E. N. Wentworth.

Factors are recognized in horse color. The terminology of Sturtevant is used in part. $C =$ red or yellow basic pigment, possibly partially diffuse; $H =$ Hurst's factor or black; $B =$ restriction factor producing bay. This is the principal new feature in the paper. B restricts black to the extremities, *i. e.*, eye, mane, tail, lower limbs, etc. The ability of the chestnut horse to carry this factor and in mating to blacks to produce bays explains a phenomenon that has been more or less of a stumbling block. Factors for gray pattern, roan pattern, dappling pattern, white stockings and blaze in face, and for piebald and skewbald markings are identified. Browns are distinguished from bays by the presence of the dappling factor. Tables showing results of over 12,000 matings are appended.

Some Factors Affecting Fetal Development: JOHN M. EVVARD.

The author showed that the size, weight, strength, vigor, character of coat, size of bone and general thrift of the newborn were markedly affected by the nutrition of the dam during the period of gestation. The specific food constituents which when added to corn produced positive results were protein and calcium, both of which (when added to corn) produced larger and heavier offspring than when corn alone was used. The importance of calcium was emphasized by calling attention to the fact that ordinary animals contain practically two thirds as much calcium as of nitrogen in their bodies. Using analytical figures as a basis, the investigation showed that the sow to produce a normal ideal litter would have to eat not less than 13 pounds of corn daily to secure enough calcium for said litter, and this on the assumption that all the calcium was perfectly utilized without any waste whatsoever, no allowance being made for the metabolic uses of the dam herself. The work was done upon sheep and swine. This direct quotation is of interest. "Realizing that the development of the organism may be hindered as early as the embryonic and uterine stages is quite suggestive of a rational diet during the entire period of gestation. Those pregnant animals which are forced to subsist upon grain diets are much more unfortunate than those which have their digestive systems so constituted as to avail themselves of considerable roughage, which, if they be legumes, are very advantageous in the production of vigorous newborn offspring. It is quite fortunate indeed that the mother is able to store in the bones and tissues of her body a considerable amount of material which will tide her over periods of scarcity and enable her to give birth to her young even though the essential constituents are lacking to a large extent in the pregnancy feed."

A Case of Urticaria Factitia: WALTER S. NEWELL.

During a course of elementary experiments in the "tactual localization of a point" it was observed that in the case of Miss M., wherever the tactual stimulus was applied a round welt or wheal arose. These welts, which resembled bee stings, measured from 3 mm. to 5 mm. in diameter and varied in size with the instrument used in giving the tactual stimulus. The sharp corner of a card drawn lightly across the skin produced a line of bead-like welts. The welts appeared within three minutes after the stimulation and reached the maximum of vividness within five or ten minutes. They remained visible from half an hour to an hour and a half. Tests were tried with Miss M. at different hours of the day and at intervals of several days for a period covering eight weeks. Experiments showed that she exhibited this sensitiveness over widely distributed areas of the body, but no results could be obtained on the finger-tips or on other calloused portions. Most of the observations were made upon the forearm, both on the front and on the back of the arm. A careful study of Miss M.'s nervous organization, with the testimony of several of her instructors, supplied abundant evidence of her instability, and pointed toward a functional disorder caused by "nervous irritability, emotion and hysteria." A striking array of concrete instances of Miss M.'s nervous eccentricities could not be overlooked among the facts most significant in the diagnosis.

Several tests were made to determine whether the "autographisms" could be caused by suggestion or by any means other than actual contact. No results were obtained in this series of experiments, but this may be due to the subject's inability to fixate her attention for any length of time. The lightest contact was followed by the graphism, however, and according to Miss M.'s own testimony she has "known of this sensitiveness since childhood, but has never regarded it as anything unusual."

No attempt was made to use hypnotic suggestion as a means of inducing the graphisms. The subject's introspections are at times contradictory, although quite in accord with her own mental instability. This case throws a sidelight upon the prestige which in another age or in a different environment would be sufficient to lead to all degrees of religious extravagance or fanaticism.

Officers elected for the ensuing year are:

President—C. N. Kinney, Des Moines.

First Vice-president—H. S. Conard, Grinnell.

Second Vice-president—Henry Albert, Iowa City.

Secretary—L. S. Ross, Des Moines.

Treasurer—G. F. Kay, Iowa City.

Elective Members of the Executive Committee—E. N. Wentworth, Ames; E. J. Cable, Cedar Falls; A. G. Smith, Iowa City.

The next annual meeting will be held at the State Teachers College, Cedar Falls, Iowa.

L. S. ROSS,
Secretary

DRAKE UNIVERSITY,
DES MOINES, IOWA

SCIENCE

FRIDAY, AUGUST 22, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

PRESIDENT'S ADDRESS AT THE INTERNATIONAL MEDICAL CONGRESS[1]

A WHOLE generation has passed away since the International Medical Congress last met in London.

What a magnificent galaxy of talent in medicine, surgery, and pathology was gathered round the Prince of Wales, who was our royal patron at that time!

It is fitting that we should follow the admonition of Ecclesiasticus and praise famous men and the fathers that begat us. Our president, Sir James Paget, was a great clinical pathologist. His mind was stored with all that was then known of the morbid anatomy of surgical disease and injury, and of the family relationships of the different diatheses. He was a splendid teacher and possessed a lucid eloquence and a moral fervor not excelled by any of his contemporaries. Jenner and Gull, Wilks and Gairdner were our great teachers of clinical medicine. Each of them based his knowledge on the same foundation of the post-mortem room and the hospital wards. We shall not see their like again, for their careers began before the days of specialization, and they were amongst the last of the great general physicians of our time. Hughlings Jackson was the philosophical exponent of the new neurology. Many of his forecasts were verified by the experiments of David Ferrier, of which I may say there was a remarkable demonstration at the 1881 congress. Jonathan Hutchinson was the patient accurate recorder of the natural history of disease in multitudinous

[1] Given by Sir Thomas Barlow, Bart., M.D., F.R.S., at the opening meeting in the Albert Hall, London, on August 6.

departments, and characteristically enough he was the organizer of our congress clinical and pathological museum. The pioneers of abdominal surgery—Spençer Wells, Thomas Keith, and Lawson Tait—were with us. Huxley, the most brilliant expositor of natural science of his time, discoursed to us on the relations of medicine and biology. William Bowman, whose work on the minute anatomy of the eye was the foundation of modern English ophthalmology, was one of our most useful members.

Last of all the Englishmen whom I will mention was our great Lister, then in the zenith of his grand career. He has but lately been taken from us in the fullness of years, and we commemorate him to-day in the medal of our congress.

Our foreign brethren were not less illustrious in the bede-roll of medical and surgical achievement. Virchow, the Nestor of morbid anatomy, honored and beloved by us as by his countrymen, delivered a fine historical discourse on the value of pathological experiments. Volkmann gave a critical survey of the recent advances of surgery. Robert Koch gave what may truly be called a path-breaking demonstration of the microbial findings in several morbid conditions, and he illustrated their characteristic growth on different organic media. Von Langenbeck and Esmarch spoke for military surgery; Donders and Snellen for ophthalmology. Baccelli, Murri, and Panteleoni represented Italian medicine. From the United States came Austin Flint, the accomplished physician and master of physical examination; Billings, prince of medical bibliographers; and Bigelow the famous surgeon.

The great French school was represented by Brown-Séquard and Charcot, Lancereaux and Bouchard and Verneuil and a host of others; but there was one great Frenchman with us who towered aloft amongst all his contemporaries, and who, though not a medical man, exercised by his discoveries a profound influence on the medicine of the world, and that was Louis Pasteur. In his address on vaccination in relation to chicken cholera and splenic fever, he gracefully linked his most recent researches with the time-honored labors of Edward Jenner on cow-pox.

Time fails me to speak of other great and honored names, but surely we may say there were giants in those days.

Now let us realize to ourselves that the congress of 1881 marked not the parting of the ways, but emphasized the notable fact that the parting of the ways had already been passed. The times of superstition, of empiricism, and of transcendental speculation had vanished. But what of the period of accurate and detailed observation? That was neither superseded nor completed, but it was already supplemented and redirected into more fruitful channels by the new development of experimental methods.

If it had not been for the work of Pasteur, Lister and Koch, which was expounded to us thirty years ago, how poverty-stricken would have been the output of medicine and surgery in this our congress of 1913!

The great men—both observers and experimenters—of whom I have spoken were like mountain peaks towering above the plain of ordinary medical humanity, and we sometimes sadly ask where are the mountain peaks now? That is a shallow and unenlightened question. For indeed, thanks to the unremitting labors of workers in multitudinous paths, we have attained a glorious heritage—not of high mountain peaks and deep valleys—but a lofty and magnificent tableland of well-ordered and correlated knowledge.

Consider the bare fact that the fifteen sections of the 1881 congress have, by the

inevitable specialization and concentration of work, become twenty-three sections and three subsections in 1913, but so imperative is the demand for mutual conference that we have no less than fourteen meetings arranged in which sections have found it desirable to discuss various problems in joint session.

In what ways have we pursued and expanded the work of our fathers? First, unquestionably, in the development and application of bacteriology. Koch's great discovery of the life-history of the tubercle bacillus was published in the year after the London Congress, and what an enormous body of knowledge has grown out of that discovery! We are learning to discriminate between the essential and causal factors of disease and the concomitants, such as combined and terminal infections. The by-products and the antibodies developed to neutralize bacterial life, of which we see the beneficent rôle in nature's own cure of an acute specific disease, have been made to yield their share in two important methods of treatment—namely, sero-therapy and vaccine-therapy.

We have also faced the problem of strengthening the phagocytosis of the patient. I need not dwell on the history of the Klebs-Loeffler bacillus and the causation of diphtheria, nor on the indubitable efficacy of the most important of all the antitoxins, nor on the singular parallelism between the bacteriological findings in atypical throat exudations with the ambiguous symptomatology which clinical observation reveals. Nor need I dwell on the extension of bacteriological investigation of typhoid fever which has been fruitful in new measures of prophylaxis and defence of the community.

We have learned something about the natural history of the ultra-minute organisms which as "filter passers" elude our microscopic investigation.

There are still great gaps in our knowledge of the bacteriology of the acute specific diseases, but it is a gain to have learned from the study of recent epidemics that infantile paralysis must be grouped with the infective diseases, and, thanks to Flexner, we know many of the reactions of its elusive organism.

Great advances have been made in protozoology, in helminthology, and indeed in the whole subject of the relation of parasites to the diseases of man and animals. In tropical diseases these studies, as well as bacteriology, have brought about a rich harvest. Malta fever, plague, malaria, sleeping sickness, have all yielded more or less of their secrets. Sometimes the whole cycle of the disease has been discovered, rationalized in every respect, and its successful treatment has been evolved.

In other cases, as in malaria, sleeping sickness, and yellow fever, where only parts of the natural history of the disease have been elucidated, nevertheless enough real knowledge has been acquired to enable important, though sometimes costly, hygienic measures to be successfully employed. Here it is fitting that we should offer our homage to our American brethren for their splendid hygienic work in Cuba, in Panama, in the Philippines and in Costa Rica, and for the efforts which they are organizing for a world-wide crusade against ankylostoma disease.

Chemical pathology has widened our knowledge and our resources, and the mystery of immunity has been to some extent illuminated.

The detailed examination of the morphological elements and the chemical characters of the blood and of other body fluids has eventuated in the rewriting of some of our physiology, and the pathological extension of the knowledge thus gained has improved the diagnosis and the treatment of several diseases. Thirty years ago Ord

demonstrated to the congress of that time examples of the disease which he had defined as myxœdema, but which, with surer instinct, Gull has described as a cretinoid state in adults. The gradual evolution of the doctrine of thyroid insufficiency and of its therapeutics is a model of induction; and this important discovery has given a great impetus to the whole study of internal secretions, as well as to the employment of organic extracts, of which the last and most interesting is that of the pituitary body.

The empirical and then the experimental study of small variations in the ordinary diets of adults and children and infants in different social strata and in different countries has been fruitful in many unexpected ways. The great milk problem is still with us, but we have learned the blunders of our early generalizations. Cleanliness in the milk supply from start to finish has a far more exhaustive meaning than in days gone by. The curious disease beri-beri, which some of us have long thought had parallelisms with scurvy, has been shown, at all events amongst rice-eating people, to depend on the loss of the nutritive material just internal to the pericarp, which the ordinary process of milling removes.

The patient study of chronic alcoholism has opened up a new chapter in nervous diseases. The routine traditional employment of alcohol in disease has happily been largely discredited. The open-air treatment of all forms of tuberculous lesions has had a wide indirect influence, not only on the treatment of other chronic ailments, but on the daily life of the people.

The recognition and radical treatment of oral sepsis due to damage to the gums in consequence of various disorders of the teeth has been followed by remarkable benefit. A strong case has been made out for intestinal stasis as a cause of various forms of malnutrition and for operative measures in dealing with slight mechanical obstructions; on this subject we hope for further evidence.

The additions to diagnosis yielded by x-ray exploration are like the creation of a sixth sense, and its curative applications and those of radium are the opening of a new chapter of therapeutics.

I ventured to hint that medicine has now and then led to the rewriting of some chapters of physiology, and I may add that recent researches on diseases of the heart have led to the reediting of neglected knowledge of the minute structure of heart muscle, and of orderly and disorderly mechanisms of its movements.

Of the magnificent triumphs of the surgery of this generation it is beyond my power adequately to speak, but I can refer to the wide fields opened up through the beneficent protection of Listerism. We are staggered by the reasoned and calculated audacity of our brethren when sinuses of the skull are drained, cerebral abscesses evacuated, cerebral tumors removed, the pituitary body even being investigated, when pleuro-pericardial adhesions are freed, to the great relief of the heart, when different parts of the alimentary canal are short-circuited and when one or other damaged viscus is removed either entirely or in part. The active cooperation of surgeons and physicians has gained for us some knowledge of what Moynihan and others have happily described as "living pathology," and we gratefully acknowledge the invaluable information of correlated symptoms, signs and morbid conditions, and the statistics of comparative frequency which surgical experience has brought to the common store.

The supreme gain, after all, is that many more useful lives are saved than in the last generation, that the realm of grave and

hitherto incurable disease is invaded on every side, and that the danger of operation *qua* operation is retreating to a vanishing point.

It is impossible even to enumerate the varied ways in which medicine has cooperated with economics, social legislation and philanthropy, which we sum up briefly as public health. The school house and the scholars, the home of the poor, the colliery, and the factory, the dangerous occupations, the sunless life of the mentally deficient, have benefited, and will benefit still more, by its friendly invasion. And I venture to foretell that, not many years hence, every department of life and work shall be strengthened and purified and brightened by its genial and penetrating influence.

Surely I have said more than enough to justify my contention that we have come into a goodly heritage, and that that heritage is like a lofty and magnificent tableland of knowledge and efficiency. The gaps are being filled; we are no longer isolated, but are working side by side on adjacent areas which are inseparably connected. Every day we gain fresh help from the auxiliary sciences, and we realize more and more the unity and the universality of medicine.

Brethren from foreign lands, we thank you for the treasures, new and old, of observation and experiment, and of a ripe experience, which you have brought to this congress for the common weal.

I venture to affirm that the output of work of the congress week in its twenty-three goodly volumes will astonish civilized countries by its amount and its solid worth.

I welcome you to our dear country, this ancient home of freedom, and I speak not only for the medical men of the British Isles but for our brethren of the overseas dominions, who join with us in our cordial greeting.

May this congress add to the common store of fruitful and useful knowledge; may it increase our good fellowship, our mutual understanding and cooperation, and may it help to break down the barriers of race and country in the onward beneficent march of world medicine.

Thomas Barlow

CEREAL CROPPING: SANITATION, A NEW BASIS FOR CROP ROTATION, MANURING, TILLAGE AND SEED SELECTION[1]

Peoples truly rich are those who cultivate cereals on a large scale.—R. Chodat.

Forewords

1. In cereal cropping, air, water and soil fertility (plant foods) are primary matters of crop productivity.

2. The problem of grain deterioration, as now observed by farmers, millers, chemists and agriculturists, the writer thinks, involves the question: "What is the matter with the crop and its product?" rather than: "What is the matter with the soil?"

3. Deteriorated wheat, as seen in depressed yields and low quality, as now quite commonly produced in the great natural wheat-producing regions of this country, is not, primarily, a matter of lost fertility or of modified chemical content of the soil, but is specifically a problem of infectious disease which is superimposed upon the problems of soil and crop management. Crop rotation, for example, is not, primarily, a farm process which is likely to conserve the fertility of the soil, but when properly arranged in a system so that the proper crops follow one another, it is definitely a sanitary measure tending to maximum production.

4. Wheat does not do well in the presence of its own dead bodies, not because of any changes which the wheat plants have made in the content of the soil fertility, nor because of any peculiar poisons (*toxines*) which the crops may be thought to have introduced, but primarily because of infectious diseases which are characteristic of the crop.

5. Proper methods of soil tillage and handling of manures and artificial fertilizers are not merely measures for supplying plant food, but also involve vital features of a sanitary nature.—Bolley.

[1] Outline of an illustrated address given before the students and faculty of the Division of Agriculture, University of Wisconsin, July 20, 1913.

Evidently the writer of the foregoing quotation, who is one of Europe's noted botanists, had in mind the evident biological fact that animal life is dependent upon plant life for sustenance, and the further fact that those countries possessed of tillable acres suitable for the growing of cereals need never suffer for food or forage, for either man or beast—need not be dependent upon other nationalities, in time of either war or of peace. That there is something vital to the thought, let us note for the time being the fearful war that the mountaineers of Montenegro have lately waged, with the hope that they might add to their domain a slightly greater area of level-lying cereal lands in the valley about them.

In late years, there has been a vast amount of talk about cereal crop deterioration, and, for many years, much has been said about "depleted or worn-out soils," and the writers and talkers have lectured and scolded with a vim as strong as though they believed the air supply of the earth were actually proved to be limited (which possibly it is) and that the mineral elements of the soil were rather readily to be lost.

In cereal cropping, this talk and scolding has reached a stage when most of it is mere gossip, inane higher criticism of the common farmer. In this, as in other important matters, there are now quite too many blind leaders of the blind. This is not said with any feeling of criticism, for the writer well understands the thought that where there is smoke there is fire, and further, that through agitation, criticism, contest and investigation lies the road to progress.

There is, however, at present, regarding this matter of soil depletion or cereal crop deterioration, not a little mental rambling and useless counter-criticism among the so-called scientists and agricultural "experts," a tendency to study over the work done by others in similar lines for the apparent purpose of finding and fighting error. The words scientist and expert, in this particular regard, are much overworked. For the benefit of the common farmer, at least that he may escape confusion, we should give these words a rest. It would be less confusing to the general public if no titles were given to those who are trying to instruct on such a difficult phase of nature as how plants and animals live—if they were not led to expect too much, only to meet with repeated evidence of fallibility of supposed agricultural principles.

Within the past twenty-five years great progress has been made by the students of agriculture and of science in general in divorcing the work of life from mere mental philosophizing and in carrying principles of investigation direct to the field of work. In the manufacturing line, this has been done very directly. In the agricultural field we must, without sacrifice of accuracy of detail, do the same thing much more definitely than it has yet been accomplished, if the students of agriculture are to aid the farmer in the way that he must be aided if he is to understand the relation of science to his life work. The introduction of the agricultural college and experiment station idea started out with this thought strongly in mind, though the workers were poorly equipped for the ordeal. These institutions are now becoming powerful, even luxurious in equipment, and it is not at all without the possibility that in our intense desire to be scientific and accurate, and in our worship of the high culture and the accomplishments of the savant, too many of our workers who are paid to investigate agricultural problems may only investigate for their own

enjoyment—may again deal in formulas, and theories, books and philosophies, and thus give out to the working public fine philosophies which may yet leave the worker helplessly in the dark as to what to do.

My belief is that those who undertake to improve agricultural methods, who undertake to furnish the principles which shall direct farm processes, must not be satisfied with the mere study of such principles in the laboratory and the writing of books, which books and pamphlets, because of the nature of things, will be used by laymen for the instruction of the worker. Such men should dictate to themselves the study of actual life conditions of the particular crop which they have under consideration. In directing farm operations so that they shall leave the toiler any remuneration, the scientist must remember that reasoning by analogy is not apt to give him a reputation of infallibility before the farming public.

This is one of the common errors of the present advocates of crop rotation. They give almost every conceivable reason why a crop rotation should be conducted, other than real reasons why the crop grows better under a particular type of crop rotation. For example, one of the chief arguments is that the farmer will have more kinds of crop to sell—will not have all his eggs in one basket. The writer considers such an argument as no reason at all for crop rotation. Indeed, all other types of business are conducted on the opposite basis, namely, a man should do one thing and do it well, and the farmer can not understand the business or professional man who reasons one way for himself and another for the farmer.

It is my belief that the present reason why crop rotation and proper systems of manuring are not properly followed rests not in the innate shiftless or disinterested nature of the American farmer, but because *such* secondary reasons have been given in lieu of real arguments. For example, crop rotation has almost invariably been argued on the basis that it rests the land or improves its fertility, and yet we have been unable to find any proof whatsoever of the truth of such assertion. The writer believes the reason farmers have not followed a persistent and consistent crop rotation is due to the fact that we have not heretofore been given the real reasons which primarily or essentially demand crop rotation in order that healthful, proper yielding plants may be produced on the land.

It is confusing to the farmer and to the layman teacher to read the recriminating criticisms of criticisms, as to the principles of agriculture. Error does not need to be fought, for it falls of its own weight when truth arrives. We are, therefore, I think, to be highly congratulated in this country over the present evident intention of our government and our schools and our investigators to carry the work into the field, whereby the investigator himself becomes more closely the instructor. Middlemen we must have in this work, but let them be as few as possible. I think those investigators of farm problems who have had experience will invariably agree with me that they have encountered much more difficulty in educating the philosophizing institute or extension worker than they ever experienced in getting a farmer of average intelligence to adopt a particular principle under consideration.

The Influence of the Laboratory Chemist.—I am no pessimist as to the value of present scientific methods. They are a matter of development, but there can be little harm done in calling attention to possible improvements in the methods. The laboratory chemist, because of his first

active occupancy of the scientific field and because of the very vital problems with which he deals, whereby each one of the natural fields of science must depend upon him for facts as to the construction of matter, has always had a very strong influence upon the formation of all our theories and principles of agriculture, and I think I may not be open to too strong criticism when I say that we have allowed the laboratory chemist and the untrained middleman or field agriculturist who, in the past, has taken his doctrines largely from the assertions of the chemist, to lead us past many of the problems in cereal cropping.

In this matter of depleted soils and deteriorated cereal crops, it may be admitted that there *are* depleted soils—soils too poor to grow pay crops of any one of the cereals, but they are not, in the belief of the writer, located in any of the present great natural wheat- or cereal-growing regions. The great flat prairie lands of this country which are now producing the so-called deteriorated types, black-pointed, white-bellied, piebald wheat with attendant low yields per acre, are not comparable in the difficulties of maintaining fertility with the denuded water-washed hills of New England, New York, Maryland or Virginia; nor should they be classed with sewage-clogged lands as described by Russel and Hutchinson of the Rothamsted experiments. When I say this for the American natural wheat-producing areas, I may say that I have investigated the problem sufficiently to feel certain that the worldwide problem is comparable to our fertile land problem, is, in fact, in large part the same problem.

Soils may blow away, wash away, or may be sewage-clogged, but these are not, at present, the chief reasons for low yields of wheat, oats and barley in certain naturally very fertile lands of Wisconsin, Iowa, Minnesota, the Dakotas and northwest Canada, or indeed, of the old winter wheat lands of southern Ohio or Indiana.

That you may feel certain of where I stand in the matter, I feel justified in asserting, from my studies and those of various assistants who have been aiding me in my investigations of problems of cereal deterioration, that the chemists are now no more nearly accurate in their diagnosis of the chief wheat troubles in these and other natural wheat-cropping areas than they were a generation ago when the most expert among them insisted that the methods of the chemical laboratory would allow them to determine whether water is fit for drinking or not. They could not then tell whether water would or would not produce disease and death. Neither can the chemists in their laboratories determine the probable productivity of a particular piece of wheat soil. It seems clear, from the investigations of many men, that chemical analysis is no longer the yard-stick for the measure of the productivity of a soil. Rather must we say that *the real measure of the fertility of a soil is the crop which it will produce under a given method of procedure, tillage, drainage, rotation, etc.*

I would remind you that I am not talking against the use of fertility in the growing of crops. I know well the list of essential chemical elements that must be present in a soil in certain reasonable proportions in order that there may be a crop produced. I would remind you, however, that this is not the problem under consideration. The problem under consideration is: Why is it that fertile wheat lands do not produce wheat of reasonably normal quality? Why is it that the yield per acre diminishes rather than increases in spite of present best methods of agriculture?

I again assert, the chemists are not more able to tell by chemical analysis of a wheat

soil whether it will produce normal wheat under normal weather conditions than they were able, twenty-two years ago, to predict whether a certain soil would or would not produce a scabby, gnarled, bin-rotting lot of potatoes. Nor are they any nearer accurate in their diagnosis of the causes of the irregularities of results which are attendant upon present best methods of crop rotation and especially attendant upon the results of the one crop system of wheat growing, than they and others were, but a few years since, when it was continually reiterated that flax wears out or poisons the land against its own growth, that flax is a very "destructive crop on fertility," that flax is very "hard on land," etc., that flax "should have a deep, loose, mellow seed bed and be highly manured if one expects to succeed with it at all." All of which assertions have been abundantly disproved within the past fifteen years.

The chemist and his followers might not have made these errors had the laboratory investigators been willing to go more often into the flax fields and to delve more deeply into the dirt rather than more deeply into the archives of written books to gain ideas as to why the crop was dying.

The Present Status of Cereal Cropping.—That there is a real problem before the agriculturists of the world, especially as affecting the question of maintaining the output of wheat in amount and quality, all must agree. The present approximate annual output of 700,000,000 bushels in its occurrence is somewhat analogous to the varying annual output of gold. It is maintained at these approximate figures, essentially not through increased yields of grain of better quality per acre on old cultivated areas through certain exact methods, but rather through the breaking up or turning over of new areas, in the same wasteful methods. The most alarming feature of the whole condition rests not so much in these facts as in the evident rapid deterioration of the quality of grain which invariably accompanies the first few years of cropping upon the new land areas. Indeed, in some of the newer great wheat-producing regions the most fertile new lands do not produce wheat now either in yield per acre or in quality similar to that which adjoining lands did when first put under wheat culture. This and similar problems the writer believes he is now able to explain. Commonly, the new lands at first, even though of light texture, and of low chemical fertility, are expected and usually do produce grain above the ordinary average as to quality in color, form and milling texture, but, very soon, in spite of the best teachings of our experiment stations and most noted agricultural advisers and experts, even though they themselves attempt the culture, the yield per acre and the quality drops off to such extent that the millers complain bitterly. There is no certainty of quality (grade) occurring, year by year, regardless of the native fertility of the soil whether high or low. The best old cropped soils which the chemist himself will assert are of higher fertility than many of the new unplowed lands, are no more certain of giving success with wheat as to these matters of grade and milling quality than the very poorest. This is but to be expected, for even though there be only fertility of a particular type sufficient for three or four bushels of seed per acre, biologically, there are no reasons why the crop should not, under conditions of health, mature normal seed.

On account of all these conditions of low yield and invariable deficiency in quality, there has gone up a great cry of "depleted" soils, "worn out" land, "bad agriculture," "shiftless methods," etc. This cry follows the plowman regardless of his

improved tools and general farming improvements, regardless of better methods of tillage which we know now obtain on the farm, as against those which our forefathers were able to accomplish, and all regardless of hard work. It is all right for the banker and the lawyer, and even some professors, to berate the farmer for idleness and inefficiency in methods and lack of business, but I say let such men try to raise wheat of high grade under the present general understanding as laid down in books, or by our best agriculturists. In spite of all these directions, the wheat soon becomes soft and shows all of the peculiar characteristics which we find named in the literature of the chemical laboratory, or in the milling tests of wheat as previously indicated, "white-bellied," "piebald," or shrivelled, bleached and blistered, "black-pointed," in fact all of the qualities of deteriorated grain; and the chemist from his laboratory outlook cries out "depleted soils," "lost fertility," "bad physical texture," due to "worn-out humus," "lost nitrogen," "insufficient phosphates," "lime," etc., forgetting, as it were, that almost every field in these matters is a law unto itself and that every one of these fields in the next few years may contradict all these assertions by the growth of splendid crops for reasons no one seems to know. The expert agriculturist and agronomist, who take their cue largely from the chemists, cry out: "Give us intensified agriculture," "Apply phosphates," "Apply lime," "Apply potash," "Grow clover," "Raise corn," "Rotate," all in a confused jumble, and lately the bankers, afraid of their mortgages, have become very busy and tell how to farm and scold rather strongly about lack of business methods on the farm, berate the schools, etc.

These conditions of farm cropping, though not exclusively American, are especially in prominence at present because many of our most noted publicists are becoming, perhaps properly, alarmed. They say our farmers show no ability of maintaining the supply of wheat, the bread grain, a permanent cropping element of old land agriculture, but rather, instead, are reaping lessened yields of poorer quality from larger acreages. They are strongly impressed with the fact that the crop largely tends to disappear as a permanent factor in the agriculture of each community, and this without much apparent regard for the natural fertility of any particular soil. It is thus hardly to be looked upon with surprise that some of our most noted educators and conservationists have become somewhat disturbed and have rather loudly scolded the American farmer for supposed shiftlessness, inefficiency and lack of desire to do his work in a regular way. Some have gone so far as to call the farmer a "soil robber," forgetting that the average farmer, like other people, must live. Such men see the rapid increase of population and the rapid absorption of the public domain and associating these two existing facts with the apparent thought that any intelligent man could raise wheat if only he would follow out present best methods, begin to say harsh things, each according to his own individual make-up, forgetting, or perchance rather not seeing fully, that if he should try hard to learn how best to grow wheat, his mind would become confused by the multiplicity of advisers and the extreme variance of the explanations of why he just as often fails as succeeds when trying to follow out a given method, as, for example, of crop rotation, soil manuring or soil tillage.

The writer having grown up on the farm, and never having allowed himself to get away from the real love of working in

the dirt or soil, has found it rather easy to retain the farmers' viewpoint. In my efforts to solve farm problems through the application of botanical principles, I have invariably commenced at the farm end of the problem, and with an understanding of the farmers' explanation of the trouble. This, perhaps, in part explains why I have never been able to join the ranks of those who scold the American farmer for supposed things left undone. Personally, I have learned that when I have known a principle of plant production and have myself been able to put it into action, I have never had any trouble to get the average farmer to understand that principle and put it into practise. Thus if I were to turn scold, my arraignment would not be against the farmer, but rather against those who have been and are now too cocksure of their scientific principles as worked out in the laboratory, nor should I feel justified in very strongly scolding so-called extension workers. They are much like newspaper writers. They must interest their hearers. They must have something to talk about and can not talk more definitely than the investigators advise. I hope I may not be too pointed in this matter, for these advisers are legion. We have each been guilty of essentially the same fault, namely, the repetition of supposed best principles, perhaps, often urging them more strongly than our personal convictions would actually justify. Half truths are not apt to gain a consistent following among any class of American workers. The simple assertion that crop rotation improves the crop because it saves fertility could not of necessity appeal to the American farmer when he knows well that the next crop which follows may take out even more of the same elements of fertility than the one which has been failing. It is apparent to him that there must in some manner be a fallacy in the argument. Thus it is that the writer explains the fact that there is not at present any consistent following of any definite system of crop rotation on the part of our farmers.

Rather than join the ranks of the scold, I prefer to assert that wheat-growing is a complex problem of life, and that the farmer has never been shown very definitely how to grow wheat. He has never been shown how, with any degree of certainty, to make the crop an annual pay element upon his farm. He has, to be sure, been told to "select good seed," to "practise proper tillage," "apply fertilizers," and crop rotation, etc., but oh! the confusion of all, and the uncertainty of results.

Who is there here who has the temerity to announce that he could follow the advice and win in cash returns with any annual regularity? (I am not here referring to the irregularity of present marketing conditions, but to crop returns, based on supposed fair markets.) What is the system of seed selection? What is the system of soil fertilizing? What is the system of crop rotation? and what is the *why* of each, or at least one *why* of each? Do we know the *whys* of wheat culture as for apple culture? or as for the growing of potatoes, or for the raising of the dairy cow? No, rather are we all confused, advisers and advised, much as we were with regard to potato culture twenty-five years ago.

Too many advisers are yet talking of what they see in the test tube and reporting to the farmer what they have read in books, assuming that they can thus accurately advise without studying the wheat plant in the field.

With any crop, the farmer must be given something definite to do that may give the expected results, at least somewhat more often than not. This information he does

not now have available as to wheat and cereal cropping. That he succeeds as well as he does is proof positive that cereals are sturdy crops. Wheat, for example, is among those crops which man has always had with him since he became reasonably intelligent, and it is probable that only the survival of the fittest, acting under the many interfering unintelligent activities of man, now accounts for the fact that our wheat yields remain as high per acre as they do.

The writer is one of those who believes that *disease, as a factor, has been one of the main agents of elimination, directing the survival of the fittest among cultivated plants as among peoples themselves.* I also believe that when we get our people to understand this problem, the question of sanitation, both our home life and farm cropping work will have a new meaning of very great importance to the public.

The Problem not Alone an American One.—That the problem of deteriorated yields in quality in cereals is not alone an American problem is evident from the literature now appearing in England and other European countries, especially, at present emanating from the Rothamsted farm. By our noted American agriculturists we have been almost led to believe that they had no wheat problems at the Rothamsted farm. All were settled by well-worked-out theories of soil fertilization and crop rotation. Our farmers have been told that if they would do likewise (which is an essential impossibility under present farm conditions) they would have no trouble in boosting our annual yield to 25 or 30 bushels per acre.

When it has been needed to drive our farmers a little harder, we have not hesitated to say to them, "Look at the wheat yields of England, France and Germany," apparently all oblivious of certain great differences in farm conditions existing there which do not exist and which can not exist here for many years to come, and to the further fact that in proportion to their intensified conditions of agriculture, they have the same great proportionate variations in yearly success. Their grains show the same signs of deterioration and they have the same uncertainty that the crop will pay for the labors and money expended. The writer now knows that their troubles are primarily the same as ours. If we are to judge from the reports from the Rothamsted Farm, they have no clearer explanation of the wherefor of the ill effects of continuous cropping than has been given by our own agriculturists who have but largely repeated old explanations.

Theories.—There are many theories as to the causes underlying these irregularities as to cereal-cropping under special methods; especially as to the causes underlying *apparent* soil depletion and wheat deterioration.

1. The Lost Fertility Theory: For ages the farmer has known that proper food prevents starvation, that hay and grain make the fat horse, etc., and from experience knows that what he calls a fertile black, mellow, tillable soil commonly makes strong plants; that farm manures generally tend to give crop increase, though in the case of cereals there is no certainty of this. There may be increased yields, with vital deterioration in quality of seed produced. He has, however, always lent a willing ear to the fertility doctrine and has willingly looked to the chemist to tell him what to do, what to eat, drink, and what to feed his stock. From this vantage point the chemist has from the first had slight trouble in dictating from the laboratory the measure of soil fertility, but I think I am safe in saying that he never has been able to explain why fertile soils and nor-

mal weather conditions do not always measure the crop in yield and seldom in quality. He settles the matter by citing the probability of soil depletion in some measurable available matter of plant food; when this is supplied, if the crop yet fails, he circumlocutes the question by the assertion that there is "bad agriculture," and if the farmer is unconvinced, he and the farmer together are apt to blame the weather or the variety.

2. The Toxine Theory: The farmer, used to the observation that a single crop system sometimes gives sickly-looking plants and failing crops, and that a long rest of the land or a change of crop seems to tend to correct the difficulty, and associating these conditions with the well-known fact that animals, including man, too closely housed and associated with their own kind in large numbers fail to thrive, has always had a dim suspicion that when certain cropping plants are too thick on the land or too continuously returned there, they may tend to poison the ground for their own growth. Certain bacteriologically inclined chemists, or rather, perhaps, bacteriologists with chemical training, unduly impressed with the fact that animals and plants and especially bacteria in a closed space throw off substances toxic to themselves, have of late invented a very plausible poison, toxine or excreta theory by which they reason that plants may poison themselves or introduce into the soil substances poisonous to following crops of the same sort. Some even go so far, apparently, as to believe that almost any soil may contain such organic substances. Thus, for example, Russell and Hutchinson, of Rothamsted, seem to think that a study of cabbage-sick soil might explain barley-sickness; that a study of sewage-logged soil might explain wheat-sickness on arable soils, and Professor Whitney has even tried to explain that grass fails to grow under a tree because of the excreta thrown off by the tree.

3. The Ammonification Theory: Certain of the bacteriologists, over-enthusiastic as to the efficacious power of bacteria to change organic substances into nitrate nitrogen, etc., seem to imagine that cultivated plants could not live in fertile soil without the activity of such organisms. Unable to get away from their chemical training, they attribute almost all of the powers of a soil to produce a crop to the bacterial flora, and have builded about bacterial activities what I think I am correct in naming the "nitrification, ammonification denitrification theory" of crop production, until, when one reads their writings he must, if he assents to their assumptions, believe that a wheat plant could not be expected to thrive in a fertile soil in the absence of such nitrifiers, ammonifiers and denitrifiers in fine adjustment.

4. The Amœboid or Denitrification Theory: Finally, at Rothamsted, England, a subdivision of the latter school of chemical bacteriologists has risen who would grant the essentials of the ammonification theory, but are unable to account for the fact that often in the presence of a highly nitrogenous and otherwise fertile soil there is yet crop failure and irregularity of crop as to quality. They would explain such irregularities or apparent soil deficiencies in crop production by assuming that the proper balance of bacterial flora in the soil has been interfered with. This they explain by the assumption (wholly groundless, I think) that certain amœbæ or other organisms, which, for lack of better name, they call biological factors, eat up the good bacteria, the nitrifiers and ammonifiers and for some reason are unable to digest the denitrifiers, forgetting, apparently, the short life of all of the organisms thus concerned and the evident fact that such a

process could only result in a continuous freeing of fertility. These authors have also apparently made the mistake of studying some other soil than the one which should be studied. All of the phenomena which they mention for sewage-sick soil can in all probability be explained on normal chemical, physical and biological grounds without the necessity of introducing a reversed Metchnikoff theory.

It will be noted that all these theories have a strong chemical bearing, that, in fact, all are trying to explain crop deterioration on the basis of chemical depletion or modification of the soil. They, apparently, all ask: "What is the matter with this soil?" rather than, "What is the matter with the crop?" They do not allow the cropping plant much character of its own as to ability to feed itself when fertility *is* available; and, to my thinking, there is a stumbling block in the way of all these theories. None of them explain immediate crop failure or modification on virgin lands, nor do they explain the production of seed of deteriorated quality on old-worked lands of high available fertility.

As to explaining the types of seed deterioration which the millers have under discussion, I am convinced all fail. Our experiments teach that there are other interfering causes than lack of fertility or of the presence or absence of toxines in the soil, or the presence or absence of a particularly good bacterial flora, or the presence or absence of amœboid organisms which feed upon them. For example, in the case of fruit culture, vegetable gardening and potato culture, I would call attention to the fact that sanitation applied to cropping methods has made a record which should long ago have aroused the chemists and the teachers of agriculture from their apathy with regard to the influence of interfering diseases upon cereal cropping.

I recognize that soil fertility in chemical matter, taken with climate and variety, constitute the primary gage of the crop-producing power of a soil, but I also feel sure that I am pointing out the chief interfering factor which accounts for the irregularities in cereal crop production, namely, *infectious disease resident in the seed and in the soil.* My experience with, observation on, and experiments upon potato-sick soil, flax-sick soil, wheat-sick and oat-sick soils leave me no room to doubt that the various chemical theories of soil deterioration or depletion do not in any way explain the causes of deteriorated grain as seen under the one-cropping system on soils which are characteristically cereal lands. Soil fertility is primary, but a disease problem is superimposed.

Root diseases of cereals, as in the case of potatoes, in all probability account for many of the confusing results which have been obtained under the best and most persistently conducted series of crop rotation, soil fertilization, water culture experiments, etc. These experimenters never used, with certainty, healthy seedlings. When they used manure, they sometimes did and sometimes did not introduce crop-destroying diseases. When they have used artificial fertilizers they sometimes did and sometimes did not apply them to the crops which were particularly subject to disease. So, also, in the past conducting of variety tests of cereal grains, the results are very largely vitiated. In the presence of disease, a resistant variety has been given undue credit for yield and quality, while a non-resistant variety has been unjustly militated against.

My experience with cereal crops with reference to the application of fertilizers, the trial of varieties, experiments in seed selection, seed breeding and seed treatment, and seed purification furnish data which

will allow me to say that I have no fear that all will eventually agree that sanitary considerations with reference to the characteristics of parasitic diseases which are now quite commonly resident in the seed and the soil will yet form the essential basis for the proper management of crops in rotation in series, and the same considerations will largely govern the type of tillage and the manner of handling waste materials on the farm, particularly farm manures. Further, aside from the matter of variety as to food value, the efforts of agriculturists and agronomists with reference to cereal cropping will, in the future, give primary consideration to the selection of seed for sowing purposes, based directly upon its powers of resistance to disease.

The ability of our farmers to do all these things can not be questioned, and when they realize that health among cropping plants is far more important because of the close association of individual plants in the soil, than it is with reference to animal life, they will understand, and will put into action proper sanitary measures for disease control in cereal cropping.

H. L. BOLLEY

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May 14, 1913

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES

TABLE I

Doctorates Conferred

	Average of 10 Years, 1898–1907	1908	1909	1910	1911	1912	1913	Total for 16 Years, 1898–1913
Columbia	32.2	55	59	44	75	81	66	702
Chicago	35.6	54	38	42	55	57	46	648
Harvard	33.8	42	38	35	42	41	52	588
Yale	31.8	32	44	27	31	31	39	522
Johns Hopkins	30.5	28	27	23	28	32	32	475
Pennsylvania	22.5	32	29	26	29	34	31	406
Cornell	18.1	22	34	35	34	33	35	374
Wisconsin	8.6	17	16	18	23	27	19	206
Clark	8.7	11	9	14	16	6	16	159
New York	6.7	15	13	11	17	10	16	149
Michigan	6.9	4	13	7	6	11	15	125
Boston	4.4	11	13	6	13	8	9	104
California	3.3	4	10	6	6	15	6	80
Princeton	2.6	6	4	8	9	12	13	78
Illinois	.5	5	4	12	11	20	20	77
Bryn Mawr	2.1	4	2	5	5	9	3	49
George Wash.	2.8	3	4	4	5	2	2	48
Virginia	2.8	4	1	4	2	4	4	47
Brown	2.3	2	5	1	4	6	1	42
Catholic	2.0	1	3	3	5	5	3	40
Minnesota	2.4	3	5	1	2	2	3	40
Stanford	1.4	2	3	5	4	4	5	37
Iowa	1.1	2	0	4	3	7	3	30
Nebraska	2.0	2	2	1	0	3	2	30
Mass. Inst.	.3	3	0	3	2	6	1	18
Cincinnati	.3	0	2	2	5	3	2	17
Indiana	.0	3	3	0	2	4	3	15
Ohio	.4	0	2	0	2	5	1	14
Pittsburgh	.1	4	0	2	1	1	5	14
Washington	.7	1	0	0	2	1	3	14
Missouri	.4	3	0	2	2	1	1	13
Vanderbilt	.6	1	1	2	0	1	2	13
Georgetown	1.0	0	0	0	0	0	0	10
Colorado	.5	0	1	0	0	0	1	7
Kansas	.3	0	0	3	1	0	0	7
Syracuse	.2	0	2	1	2	0	0	7
North Carolina	.5	0	1	0	0	0	0	6
Northwestern	.4	0	1	0	1	0	0	6
Tufts	.5	0	0	1	0	0	0	6
Wash. and Lee	.4	1	0	0	0	0	0	5
Lafayette	.3	0	0	0	0	0	0	3
Dartmouth	.1	1	0	0	0	0	0	2
Lehigh	.2	0	0	0	0	0	0	2
Tulane	.1	0	0	0	0	0	1	2
Total	272.4	378	389	358	445	482	461	5,237

AS shown by the tables published on the following pages, the notable increase in the number of degrees of doctor of philosophy and of science conferred by American universities in 1912 has been followed by a small decrease in 1913. The total number of degrees this year is 461, as compared with 482 last year; the degrees in the natural and exact sciences fell from 273 to 231. Such fluctuations are not, however, significant, being due to natural variations in statistics when the total number of cases is comparatively small. It is not likely that the number of degrees conferred in any future year will fall appreciably below the record for the present year, whereas the average for the first five years covered by these statistics was 233. This represents a doubling of graduate and research

TABLE II

Doctorates Conferred in the Sciences

	Average of 10 Years, 1898–1907	1908	1909	1910	1911	1912	1913	Total for 16 Years, 1898–1913	Per Cent.
Chicago	16.4	37	20	24	35	37	16	333	51
Johns Hopkins	16.8	17	20	15	19	23	21	283	60
Columbia	13.4	21	23	11	29	36	27	281	40
Cornell	10.4	15	24	27	27	28	30	255	68
Harvard	14.1	13	14	10	20	15	22	235	40
Yale	12.4	16	27	12	15	21	19	234	45
Pennsylvania	9.0	18	13	12	10	9	9	161	40
Clark	7.7	11	8	14	16	6	13	145	91
Wisconsin	2.8	6	4	13	13	14	5	83	40
California	2.4	2	6	4	5	12	6	59	74
Michigan	2.8	1	5	1	3	8	10	56	45
Illinois	.3	0	2	9	6	15	11	46	60
Princeton	1.1	3	3	2	5	7	7	38	49
George Wash.	1.7	2	2	3	4	2	1	31	65
Stanford	1.1	2	2	1	4	3	5	28	76
Brown	1.2	2	2	1	3	4	1	25	60
Nebraska	1.3	1	2	1	0	0	2	19	63
Virginia	1.1	2	0	1	1	2	2	19	40
Mass. Inst.	.3	3	0	3	2	6	1	18	100
New York	.6	1	3	2	1	2	.3	18	12
Bryn Mawr	1.0	1	0	2	1	3	0	17	35
Minnesota	.7	1	2	1	2	2	2	17	43
Iowa	.7	0	0	2	1	3	2	15	50
Washington	.7	1	0	0	2	1	3	14	100
Indiana	.0	3	3	0	2	4	1	13	87
Ohio	.4	0	2	0	2	5	0	13	93
Cincinnati	.1	0	1	1	4	1	2	10	59
Missouri	.3	2	0	2	2	0	1	10	77
Catholic	.5	—	2	0	1	1	0	9	23
Pittsburgh	.0	0	0	1	1	1	5	8	57
Kansas	.3	0	0	3	1	0	0	7	100
Vanderbilt	.3	1	1	0	0	1	1	7	54
Boston	.1	0	1	0	0	1	2	5	5
Tufts	.5	0	0	0	0	0	0	5	83
North Carolina	.3	0	1	0	0	0	0	4	67
Northwestern	.2	0	1	0	1	0	0	4	67
Wash. and Lee	.3	1	0	0	0	0	0	4	80
Syracuse	.1	0	0	1	1	0	0	3	43
Colorado	.2	0	0	0	0	0	0	2	28
Dartmouth	.1	1	0	0	0	0	0	2	100
Lehigh	.2	0	0	0	0	0	0	2	100
Georgetown	.1	0	0	0	0	0	0	1	10
Lafayette	.1	0	0	0	0	0	0	1	33
Tulane	.0	0	0	0	0	0	1	1	50
Total	124.1	184	194	179	239	273	231	2,541	49

TABLE III

Doctorates Distributed According to Subjects

	Average of 10 Years, 1898–1907	1908	1909	1910	1911	1912	1913	Total
Chemistry	32.3	54	43	48	68	78	68	682
Physics	15.5	22	25	25	33	30	21	311
Zoology	15.2	25	18	24	25	20	24	286
Psychology	13.5	23	21	20	23	29	24	275
Mathematics	12.1	23	14	23	25	22	20	248
Botany	12.6	11	16	10	20	30	27	240
Geology	7.1	5	13	10	15	23	14	151
Physiology	4.1	7	13	4	2	12	2	81
Astronomy	3.4	1	7	3	4	2	11	62
Agriculture	1.0	2	7	4	11	11	8	53
Bacteriology	1.4	1	5	1	4	6	3	34
Anthropology	1.0	4	4	2	2	0	3	25
Anatomy	.9	2	0	1	1	6	1	20
Paleontology	1.6	1	0	2	0	0	0	19
Pathology	.5	2	3	1	1	2	2	16
Engineering	.8	0	0	1	2	2	0	13
Mineralogy	.6	0	3	0	1	0	0	10
Metallurgy	.3	0	1	0	1	0	0	5
Geography	.1	1	1	0	1	0	1	5
Meteorology	.1	0	0	0	0	0	0	1
Total	124.1	184	194	179	239	273	231	2,541
English		30	27	31	35	30	39	192
History		32	22	25	28	20	25	152
Economics		17	42	7	17	26	16	125
Philosophy		25	14	19	26	15	22	121
Education		6	9	13	23	21	25	97
Latin		12	12	15	13	17	19	88
German		14	14	16	8	15	21	88
Romance		12	16	6	12	15	9	70
Sociology		6	6	14	18	12	11	67
Oriental		9	15	11	1	10	8	54
Political Science		9	4	9	6	9	15	52
Greek		13	11	5	7	5	8	49
Theology		7	2	1	7	7	6	30
Philol. and Com. Lit.		0	1	5	1	2	3	12
Law		1	0	1	2	1	1	6
Classical Arch.		0	0	0	1	3	1	5
Music		1	0	1	1	0	0	3
Fine Arts		0	0	0	0	1	1	2
Total		194	195	179	206	209	230	1,213

work in our universities within fifteen years. It is, however, still the case that, in proportion to its population, Germany has six times as many men officially certified as competent to undertake advanced teaching and research work.

From 1898 to 1907 five universities—Chicago, Harvard, Columbia, Yale and the Johns Hopkins—conferred nearly equal [illegible] at Chicago to 305 at the Johns Hopkins, but during the last six years these five universities have arranged themselves somewhat definitely in the order shown in the table, and it seems not improbable that this order will be maintained for a long time. Pennsylvania and Cornell have in this period come into the same group as

Yale and the Johns Hopkins. The most notable advance, however, has been in the case of the state universities, especially Wisconsin, Michigan and Illinois. Both last year and this the last-mentioned university conferred twenty degrees, whereas during the entire ten-year period from 1898 to 1907 only five degrees were conferred. In 1912 and 1913 Princeton has also increased to a considerable extent the number of its higher degrees. This year Harvard and Yale conferred more degrees than usual, while the number at Columbia decreased. Such annual changes have, however, no special significance. This year Columbia University conferred about 500 master of arts degrees, by far the largest number in the history of any American institution.

When we turn to the degrees conferred in the natural and exact sciences, we find that Chicago and the John Hopkins have still conferred the largest numbers in these subjects, though this year they fall behind Columbia, Cornell and Harvard. Of the leading universities, Cornell and the Johns Hopkins have conferred the largest percentages of their degrees in science, 68 and 60, respectively. The percentage is exactly the same for Columbia, Harvard, Pennsylvania and Wisconsin, namely, 40 per cent. In the separate sciences there were this year 68 degrees given in chemistry, 27 in botany, 24 each in zoology and in psychology and 21 in physics. More degrees than usual were conferred in astronomy, as many as six, all the degrees the university conferred, being granted by California.

It is not altogether easy to make a satisfactory distribution of the degrees. Thus Harvard conferred degrees in applied biology and Cornell in plant breeding, and degrees may be conferred in genetics and plant pathology. It would scarcely do to have entries for subjects such as these, yet it is not certain whether they should be placed under botany or agriculture. This is only an example of difficulties which occur in all such classifications; while the table is substantially correct, it is not certain that exactly the same methods of classification have been followed from year to year.

It will be noted that while this year the number of degrees in the exact and natural sciences falls from 273 to 231, the number of degrees in the humanities is increased from 209 to 230. In the latter subjects English leads decidedly, followed by history, economics, philosophy and education. Latin and German are bracketed, while more degrees have been conferred in the oriental languages than in Greek.

The institutions which this year conferred two or more degrees in a science are: in *chemistry,* Columbia, 13; Yale, 10; Cornell and Johns Hopkins, 7 each; Pittsburgh, 5; Illinois, 4; Harvard, 3; Chicago, New York, Pennsylvania and Princeton, 2 each; in *physics,* Cornell, 4; Harvard and Johns Hopkins, 3 each; Stanford and Yale, 2 each; in *zoology,* Illinois, 5; Harvard, 4; Columbia, 3; Chicago and Stanford, 2 each; in *psychology,* Clark, 8; Chicago, Columbia and Cornell, 3 each; Iowa and Johns Hopkins, 2 each; in *mathematics,* Harvard, 4; Columbia and Johns Hopkins, 3 each; Boston, Michigan and Yale, 2 each; in *botany,* Cornell, 5; Harvard, 4; Michigan, Pennsylvania and Washington, 3 each; Columbia, Johns Hopkins and Wisconsin, 2 each; in *geology,* Johns Hopkins, 4; Yale, 3; Chicago and Columbia, 2 each; in *astronomy,* California, 6; Chicago, 2; in *agriculture,* Cornell, 8; in *anthropology,* Clark, 2; in *pathology,* Chicago, 2.

The names of those on whom the degree was conferred in the natural and exact

sciences, with the subjects of their theses, are as follows:

CORNELL UNIVERSITY

Edward Riley Allen: "The Orcinolphthaleins, the Orcinoltretrachlorphthaleins and some of their Derivatives."

Adeline Sarah Ames: "Studies in the Polyporaceæ."

Hiram Douthitt Ayres: "The Refraction of Gases at Different Temperatures and Pressures."

Henry John Broderson: "Solubilities and Chemical Reactions in Anhydrous Hydrazine."

Karl M. Dallenbach: "The Measurement of Attention."

Maxwell Jay Dorsey: "Pollen Development in *Vitis* with Special Reference to Sterility."

Alfred Washington Drinkard, Jr.: "Heredity and Variation in *Browallia*."

Mary Alida Fitch: "Studies in Transpiration."

Harry Morton Fitzpatrick: "A Comparative Study of the Development of the Fruit Body in *Phallogaster, Hysterangium* and *Gautieria*."

William Silliman Foster: "On the Preservative Tendency."

Margaret Graham: "Studies in Nuclear Division of *Preissia commutata*."

Bascombe Britt Higgins: "A Contribution to the Life History and Physiology of *Cylindrosporium* on Stone Fruits."

George Richard Hill, Jr.: "The Relation of Ripe and Unripe Fruits and Germinating Seeds to Air."

Arthur Romaine Hitch: "The Electrolytic and Thermal Decomposition of some Inorganic Trinitrides."

Earle Hesse Kennard: "The Rate of Decay of Phosphorescence at Low Temperatures."

Burton Judson Lemon: "The Electrolysis of Solutions of the Rare Earths."

James Martin Lohr: "The Tensile Strengths of the Copper Zinc Alloys."

Lawrence Martin: "Some Features of the Glaciers and Glaciation in College Fiord, Prince William Sound, Alaska."

Tanomo Odaira: "A Study of Heredity and Variation in Pure Lines and in Hybrids of *Phaseolus vulgaris*."

Martin John Prucha: "Can the Efficiency of *Bacillus radicicola* in producing Nodules on the Legumes be altered?"

Fred M. Rolfs: "A Bacterial Disease of the Stone Fruits due to *Bacterium pruni* E. F. S."

Christian Alban Ruckmich: "The Rôle of Kinesthesis in the Perception of Rhythm."

Philip Edward Smith: "Some Features in the Development of the Central Nervous System of *Desmognathus fusca* Urodela."

Vern Bonham Stewart: "The Fire Blight Disease in Nursery Stock."

Roland Elisha Stone: "The Life History of *Ascochyta* of some Leguminous Plants."

Hawley Otis Taylor: "A Direct Method of finding the Value of Materials as Sound Absorbers."

George Ellsworth Thompson: "An Experimental Study of Photoactive Cells with Fluorescent Electrolytes."

Lawrence J. Ulrich: "Equilibrium in certain Binary Systems."

Eleanor Van Ness Van Alstyne: "The Absorption of Protein without Digestion."

Thomas Whitney Benson Welsh: "Contributions to the Chemistry of Hydrazine."

COLUMBIA UNIVERSITY

Eric Temple Bell: "The Cyclotomic Quinary Quintic."

Ralph Carpenter Blanchard: "Rocks of the Western Buckskin Mountains, Arizona."

Ethel Nicholson Browne: "A Study of the Male Germ Cells in Notonecta."

Burdette Ross Buckingham: "Spelling Ability: its Measurement and Distribution."

Cora Sutton Castle: "A Statistical Study of Eminent Women."

Herbert Anthony Clark: "Selective Reflection of Salts of Chromium and certain other Oxygen Acids."

Benjamin George Feinberg: "A Quantitative Study of some Aldehyde Reactions."

H. D. Goodale: "The Early Development of *Spelerpes bilineatus* (Green)."

Gabriel Marcus Green: "Projective Differential Geometry of Triple Systems of Surface."

Joseph Samuel Hepburn: "Biochemical Studies of Cholesterol."

Ferdinand Friis Hintze, Jr.: "A Contribution to the Geology of the Wasatch Mountains, Utah."

Benjamin Horowitz: "A Study of the Action of Ammonia on Thymal."

Robert Melyne Isham: "The Preparation and Properties of certain Methoxylated Carbinols, Olefins and Ketones derived from Trimethyl Gallic Acid."

Michael Levine: "Studies in the Cytology of the Hymenomycetes, especially the Boleti."

Walter Wilbert McKirahan: "The Surface Tension of Aqueous Solutions of some Organic Salts."

Edgar Grim Miller, Jr.: "Studies in Pathological Chemistry."

Garry Cleveland Myers: "A Study in Incidental Memory."

Marks Neidle: "The Surface Tension of Aqueous Solutions of Ethyl, Methyl and Amyl Alcohols and of Acetic and Formic Acids."

William Stockton Nelms: "A Systematic Study of Linear and Non-linear Resonators for Short Electric Waves."

Anton Richard Rose: "Biochemical Studies of Phytophosphates."

Edward Schramm: "The Surface Tension of Molten Hydrated Salts and their Solutions."

George Gilmore Scott: "A Physiological Study of the Changes in *Mustelus canis* produced by Modifications in the Molecular Concentration of the External Medium."

Lloyd Leroy Smail: "Some Generalizations in the Theory of Summable Divergent Series."

Clayton Sidney Smith: "A Study of the Influence of Cold Storage Temperature upon the Composition and Nutritive Value of Fish."

Edward Collins Stone: "The Surface Tension of certain Organic Liquids and the Capillary Constants and Critical Temperatures calculated therefrom."

Arlow Burdette Stout: "The Individuality of the Chromosomes and their Serial Arrangement in *Carex aquatilis.*"

Charles Weisman: "Biochemical Studies of Expired Air."

JOHNS HOPKINS UNIVERSITY

Gardner Cheney Basset: "The Relation between Brain Weight and the Time required for Habit Formation in the Albino Rat."

Harvey Bassler: "Filicales and Pteridospermæ of the Monongahela Formations of Maryland, including certain Forms from Similar Formations in Pennsylvania."

Harry Bateman: "The Quartic Curve and its Inscribed Configurations."

Bessie Marion Brown: "On the Reactions of both the Ions and the Nonionized Forms of Electrolytes. On the Reactions of Methyl Iodide with Sodium, Potassium and Lithium Ethylates at 0° and 25°."

George Clyde Fisher: "Seed Development in the Genus *Peperomia.*"

Theodore Thornbur Fitch: "The Influence of Density of Gas on the Formation of Corona."

Marcus Isaac Goldman: "Types of Sediments of the Upper Cretaceous of Maryland."

Lon. A. Hawkins: "The Influence of Calcium, Magnesium and Potassium Nitrates upon the Toxicity of certain Heavy Metals toward Fungous Spores."

Janet Tucker Howell: "The Fundamental Law of the Grating."

Horatio Hughes: "Conductivity and Viscosity of Solutions of Rubidium Salts in Mixtures of Acetone and Water."

Willis Thomas Lee: "Stratigraphy of the Coal Fields of Northern Central New Mexico."

Florence Parthenia Lewis: "A Geometrical Application of the Theory of the Binary Quintic."

Patrick Joseph Nicholson: "Some Experiments on the Physical Properties of Selenium, with a Theoretical Discussion based on the Electron Theory."

William Armstrong Price, Jr.: "The Invertebrate Fauna of the Pennsylvania of Maryland."

Philip Schneeberger: "The Fractionation of California Petroleum by Diffusion through Fuller's Earth."

Edward John Shaeffer: "A Study of the Conductivity, Dissociation and Temperature Coefficients of Conductivity of certain Inorganic Salts in Aqueous Solution as Conditioned by Temperature, Dilution, Hydration and Hydrolysis."

James Houston Shrader: "On the Reactions of both the Ions and the Nonionized Forms of Ethylates and Phenolates with Alkyl Halides."

Leslie Denis Smith: "Conductivity, Temperature, Coefficients of Conductivity, Dissociation and Constants of certain Organic Acids between 0° and 65°.

John Linck Ulrich: "The Number and Distribution of Trials in Learning in the White Rat."

Luther Ewing Wear: "On Self-dual Plane Curves of the Fourth Order."

John Brown Zinn: "Osmotic Pressure Measurements of Cane Sugar Solutions at Higher Temperatures."

HARVARD UNIVERSITY

David Francis Barrow: "Oriented Circles in Space."

Elmer Keiser Bolton: "Some Derivatives of Iodanil."

James Wittenmyer Chapman: "The Leopard Moth and other Insects Injurious to Shade Trees in the Vicinity of Boston."

Guy Roger Clements: "Implicit Functions Defined by Equations with Vanishing Jacobian."

Donald Walton Davis: "Asexual Reproduction and Regeneration in *Sagartia luciæ* Verrill."

Richard Maurice Elliott: "The Psychophysics of Handwriting."

Rollins Adams Emerson: (*a*) "A Genetic Study of Plant Height in *Phaseolus vulgaris*"; (*b*) "The Inheritance of a Recurring Somatic Variation in Variegated Ears of Maize."

Chester Henry Heuser: "The Development of the Cerebral Ventricles in the Pig."

John William Hotson: "Culture Studies of Fungi Producing Bulbils and similar Propagative Bodies."

Roger Arthur Johnson: "An Analytic Treatment of the Conic as an Element of Space of Three Dimensions."

Augustus Locke: "The Geology of El Oro and Tlalpujahua Mining Districts, Mexico."

James Watt Mavor: "Studies on Myxosporidia found in the Gall Bladder of Fishes from the Eastern Coast of Canada."

Raymond Edwin Merwin: "The Ruins of the Southern Part of the Peninsula of Yucatan, with special Reference to their Place in the Maya Culture."

Frederic Palmer, Jr.: "Volume Ionization Produced by Light of Extremely Short Wave-length."

Chauncey J. Vallette Pettibone: "The Quantitative Estimation of Urea in Urine."

John Wesley Shipley: "Floating Equilibrium Applied to Analysis and to Precise Thermometry; and the Compressibility of certain Liquids."

Edmund Ware Sinnott: "The Morphology of the Reproductive Structures in the Podocarpineæ."

Joseph Slepian: "On the Functions of a Complex Variable Defined by an Ordinary Differential Equation of the First Order and the First Degree."

Reynold Albrecht Spaeth: "The Physiology of the Chromatophores of Fishes."

Howard Moffitt Trueblood: "On the Measurement of the Coefficient of the Joule-Thomson Effect in Superheated Steam."

David Locke Webster: I., "On an Electromagnetic Theory of Gravitation"; II., "On the Existence and Properties of the Ether."

Orland Emile White: "Studies of Teratological Phenomena in their Relation to Evolution and the Problems of Heredity."

YALE UNIVERSITY

Joseph Alfred Ambler: "A New Method of Synthesizing N-Alkyl Derivatives of α-Amino Acids."

Alan Mara Bateman: "Geology and Ore Deposits of Bridge River District, British Columbia."

Robert Bengis: "The Synthesis of Amino Acids related to Adrenaline."

Theodore Henry Brown: "The Effect of Radiation on a Small Particle revolving about Jupiter."

Wilbur Haverfield Cramblet: "On Intermediate Functions, being an Extension of Semi-continuous or Upper and Lower Functions to a Classification of Discontinuous Functions."

Ralph Dixon Crawford: "Geology and Ore Deposits of the Monarch and Tomichi Districts, Colorado."

Arthur Joseph Hill: "The Catalytic Action of Esters in the Claisen Condensation."

David Upton Hill: "Experimental Studies on the Diffusion Theory of Reaction Velocity."

Simon Boghos Kuzirian: "The Elimination of Certain Volatile Products in Chemical Analysis."

Howard Bishop Lewis: "The Behavior of some Hydantoin and Thiohydantoin Derivatives in the Organism, together with a Study of Certain Related Sulphur Compounds."

George Augustus Linhart: "On the Kinetics of the Decomposition of Certain Organic and Inorganic Salts."

Ben Harry Nicolet: "Some Derivatives of Aminomalonic Acid, and their Biochemical Interest."

Willis Clarke Noble, Jr.: "Some Investigations into the Distribution and Habitat of the *Tetanus bacillus*."

Leigh Page: "The Photoelectric Effect."

Theophilus Shickel Painter: "Spermatogenesis in Spiders."

Ruth Wheeler: "Nutrition Experiments with Mice."

Jay Walter Woodrow: "Experiments on Columnar Ionization."

Bruce Rose: "Geology of Savona District, British Columbia."

Norman Arthur Shepard: "Researches on Pyrimidines: Uramils and Thiouramils."

UNIVERSITY OF CHICAGO

Aaron Arkin: "The Influence of Chemical Substances upon Immune Reactions, with Special Reference to Oxidations."

Joseph Kumler Breitenbecher: "The Effect of Varying Water Content in the Medium upon the Activities of *Leptinotarsa decemlineata* (Say) on Introduction into a Desert Habitat."

Albert Dudley Brokaw: "The Solution and Precipitation of Gold in Secondary Enrichment of Ore Deposits."

Harold Caswell Cooke: "The Secondary Enrichment of Silver Ores."

George Oliver Curme, Jr.: "The Thermal Decomposition of the Symmetrical Diaryl-hydrazines."

Neil Stanley Dungay: "A Study of the Effects of Injury upon the Fertilizing Power of Sperm."

Curvin Henry Gingrich: "A Determination of the Photographic Magnitudes of Comparison Stars in Certain of the Hagen Fields."

Walter Samuel Hunter: "The Delayed Reaction."

George Lester Kite: "The Relative Permeability of the Surface Protoplasm of Animal and Plant Cells."

Oliver Justin Lee: "The Spectroscope System of *Camelopardalis*."

Edward James Moore: "Reaction Effects Produced by the Discharge of Electricity from Points in Oases and the Bearing of these Effects on the Theory of the Small Ion."

Fleming Allen Clay Perrin: "An Experimental and Introspective Study of the Human Learning Process in the Maze."

Mildred Leonora Sanderson: "Formal Modular Invariants with an Application to Binary Modular Covariants."

Shiro Tashiro: "Chemical Change in Nerve Fiber during Passage of a Nerve Impulse."

Arthur Lawrie Tatum: "Studies in Experimental Cretinism."

Stella Burnham Vincent: "The Function of the Vibrissæ in the Behavior of the White Rat."

CLARK UNIVERSITY

George Davis Bivin: "A Study in Psychosynthesis."

Irving Angell Field: "The Biology and Economic Value of the Sea Mussel, *Mytilus edulis*."

Erwin Oliver Finkenbinder: "The Remembrance of Problems and of their Solution: A Study in Logical Memory."

Sara Carolyn Fisher: "The Processes of Abstraction and Generalization and their Products."

Albert Nicolay Gilbertson: "Some Ethical Phases of Eskimo Culture."

Arthur Taber Jones: "Acoustic Repulsion of Jets of Gas."

Roy Franklin Richardson: "A Study of Anger."

Kirkman K. Robinson: "The Evolution of Plato's Life and Philosophy: A Genetic Study."

Frank K. Sechrist: "The Psychology of Unconventional Language."

Asa George Steele: "The Organization and Control of the College."

Miriam Van Waters: "The Adolescent Girl among Primitive Peoples."

Elizabeth Lindley Woods: "An Experimental Study of Recognition."

Elias Yanovsky: "Esterification Catalysis."

UNIVERSITY OF ILLINOIS

James Edward Ackert: "The Innervation of the Integument of Chiroptera."

James Edgar Bell: "An Improved Method for Determining the Equivalent Conductances of Strong Electrolytes at Infinite Dilution."

Josephine Elizabeth Burns: "The Abstract Definitions of the Groups of Degree Eight."

Hugh Glasgow: "The Gastric Cæca and the Cæcal Bacteria of Heteroptera."

Robert Douglass Glasgow: "Relations and Distribution of *Phyllophaga* Harris (*Lachnosterna* Hope) in Temperate North America."

John Wesley Hornbeck: "Thermal and Electrical Conductivities of the Alkali Metals."

Lloyd Francis Nickell: "Derivatives of Isocamphoric Acid, Decomposition of Isodihydroaminocampholytic Acid with Nitrous Acid."

Ralph Sydney Potter: "Molecular Rearrangements in the Camphor Series. Structure of the Amino Acids."

Harley Jones Van Cleave: "Studies on Cell Constancy in *Neorhynchus* with Descriptions of New Species in that Genus."

Paul Smith Welch: "Studies on the Enchytræidæ of North America."

Guy Yandall Williams: "The Dependence of Ionic Mobility on the Viscosity of the Medium."

UNIVERSITY OF MICHIGAN

Charles August Behrens: "An Attenuated Culture of *Trypanosoma Brucei*."

Charles Wiggins Cobb: "The Asymptotic Development for a Certain Integral Function of Zero Order."

Charles Wilford Cook: "Salts and Brines of

Michigan: their Origin, Distribution and Exploitation.''

Harry Wolven Crane: ''A Study in Association, Reaction and Reaction Times.''

Maynie Rose Curtis: ''A Quantitative Study of the Factors influencing the Size, Shape and Physical Constitution of the Eggs of the Domestic Fowl.''

Frank Caleb Gates: ''The Relation of Winter in the Xerofyty of Peat Bog Ericads.''

Clyde Elton Love: ''The Asymptotic Solutions of Linear Differential Equations.''

Walter Byron McDougall: ''On the Mycorhizas of Forest Trees.''

Charles Herbert Otis: ''Transpiration of Emersed Water Plants: its Measurement and its Relationships.''

Lambert Thorp: ''Condensation of Nitromalonic Aldehyde with Certain γ-Diketones.''

UNIVERSITY OF PENNSYLVANIA

William Elijah Anderson: ''Determination of the Mean Declinations of 136 Stars for the Epoch 1912.''

William Ira Book: ''An Electric Converter.''

Lennie Phoebe Copeland: ''On the Theory of Invariants of Plane N-lines.''

Herbert Spencer Harned: ''Halide Bases of Columbium.''

Hiram Stanhope Lukens: ''The Electrolysis of Potassium Chloride,'' ''A Study of the Action of Sulphur Monochloride on Certain Minerals,'' ''Scandium in American Wolframite.''

Thomas Franklin Manns: ''Some New Bacterial Diseases of Legumes and the Relationships of the Organisms Causing the Same.''

David Mitchell: ''The Influence of Distractions on the Formation of Judgments in Lifted Weight Experiments.''

Francis Whittier Pennell: ''Studies in the Agalinanæ, a Subtribe of the Rhinanthaceæ.''

Jacob Joseph Taubenhaus: ''Diseases of the Sweet Pea.''

PRINCETON UNIVERSITY

John Howard Dellinger: ''High-frequency Current Distribution in Hot-wire Ammeters.''

James Cook Martin: ''Geology of the Canton, New York, Quadrangle.''

Elton Leroy Quinn: ''The Atomic Weight of Cadmium by the Investigation of Cadmium Chloride, Cadmium Bromide and Cadmium Oxide.''

Edwin Eustace Reinke: ''Dimorphic Spermatozoa in Prosobranchia with special reference to their Development in *Strombus*.''

Harlow Shapley: ''A Study of Eclipsing Binary Stars.''

Guy Baker Taylor: ''The Dissociation of Mercuric Oxide: A Study of Equilibrium in the System, Oxygen and Mercury.''

Kenneth Powers Williams: ''The Solutions of Non-homogeneous Linear Difference Equations and their Asymptotic Form.''

UNIVERSITY OF CALIFORNIA

Sturla Einarsson: ''On the Orbits of the Minor Planets (624) Hector and (588) Achilles of the Trojan Group.''

Anna Estelle Glancy: ''On v. Zeipel's Theory of the Perturbations of the Hecuba Group of Minor Planets.''

Eli Stuart Haynes: ''The Minor Planet 1911 MT, (719) Albert.''

Carl Clarence Keiss: ''The Cluster Variable RR Lyræ.''

Paul Willard Merrill: ''Class B Stars whose Spectra contain Bright Hydrogen Lines.''

Emma Phoebe Waterman: ''The Visual Region of the Spectrum of the Brighter Class A Stars.''

UNIVERSITY OF PITTSBURGH

Clinton Willard Clark: ''The Pyrogenic Decomposition of Petroleum Products with special reference to Gasoline Formation by Pressure Distillation.''

Hugh Clark: ''An Improved Method for the Manufacture of Hydrogen and Lampblack.''

Harry Percival Corliss: ''The Distribution of Colloidal Arsenic Trisulphide between the Phases in the System, Ether, Water and Alcohol and the Binodal Curve and Tie-lines for the System.''

Lester Albert Pratt: ''Studies in the Field of Petroleum.''

Robert Rex Shively: ''A Study of Magnesia Cements.''

STANFORD UNIVERSITY

Samuel Stillman Berry: ''The Cephalopods of the North Pacific and the Hawaiian Islands.''

Harry Carleton Burbridge: ''The Thermal Coefficient of Contact Electromotive Force.''

Harry Drake Gibbs: ''Liquid Methylamine as a Solvent, and a Study of its Chemical Reactivity.''

Joseph Grinnell: ''An Account of the Mammals and Birds of the Lower Colorado Valley, with especial reference to the Distributional Problems presented.''

George Wilber Moffitt: "A Study of some Changes in the Air-Liquid Contact Potential Difference."

UNIVERSITY OF WISCONSIN

Irving E. Melhus: "Germination and Injection in Certain Oomycetes."

William Harold Peterson: "Forms of Sulphur in Plants."

Roy Lee Primm: "Some Phenomena associated with Cellulose Fermentation."

Nellie Antoinette Wakeman: "Plant Pigments other than Chlorophyll."

Jerry Edward Wodsedalek: "Natural History and Behavior of Certain Ephemeridæ."

NEW YORK UNIVERSITY

Raymond Bartlett Earle: "The Genesis of Paleozoic Interbedded Iron Ores."

John Wesley Marden: "The Quantitative Determination of Perchlorates and a New Method for the Determination of the Specific Heat of Dilute Solutions."

Richard Edwin Lee: "A New Decision Method for determining the Density of Liquids."

WASHINGTON UNIVERSITY

Jacob Richard Schramm: "A Contribution to our Knowledge of the Problem of Free Nitrogen Fixation in Certain Species of Grass-green Algæ with special reference to Pure Culture Methods."

Mildred Webster Spargo Schramm: "The Genus *Chlamydomonas*."

Charles Oscar Chambers: "The Relation of Algæ to Dissolved Oxygen and Carbon Dioxide with special reference to Carbonate."

BOSTON UNIVERSITY

Wilbur Alden Coit: "Introduction to Modern Geometry."

Winfield Hancock Stone: "The Elements of Harmonic Ratio."

UNIVERSITY OF CINCINNATI

Sebastian J. Mauchly: "On the Action of a Magnetic Field on the Electric Discharge through Gases."

Charles H. Hecker: "A Study of some New Alkyl Hydroxylamines."

UNIVERSITY OF IOWA

Walter Richard Miles: "Discriminative Action in Singing."

Thomas Franklin Vance: "The Psychophysics of Tonal Gaps."

UNIVERSITY OF MINNESOTA

Lillian Cohen: "Equilibria in Systems of Acetone, Water and Salts."

Elvin Charles Stakman: "A Study in Cereal Rusts: Physiological Races."

UNIVERSITY OF NEBRASKA

Claude William Mitchell: "Sex Determination in *Asplanchna amphora*."

Raymond John Pool: "A Study of the Vegetation of the Sandhills of Nebraska."

UNIVERSITY OF VIRGINIA

John Wilbur Watson: "The Abstraction of Potassium during Sedimentation."

Charles Newman Wunder: "A Photometric Survey of the Huyghenian Region of the Great Nebula of Orion."

BROWN UNIVERSITY

Norman Edward Holt: "The Action of Acetic Anhydride on *s*-Tribromphenylpropiolic Acid."

GEORGE WASHINGTON UNIVERSITY

Marcus Ward Lyon: "Treeshrews: An Account of the Mammalian Family Tupaiidæ."

INDIANA UNIVERSITY

Jesse James Galloway: "The Stratigraphy and Paleontology of the Tanner's Creek Section of the Cincinnati Series of Indiana."

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Paul Vance Faragher: "Physico-chemical Investigations on Electrolytic Potentials and on the Equilibrium of Certain Organic Reactions."

UNIVERSITY OF MISSOURI

Leroy Sheldon Palmer: "Study of the Natural Pigment in the Fat of Cow's Milk."

TULANE UNIVERSITY

Eleanor Elmire Reames: "On Fresh-water Chlorophyceæ and Cyanaphyceæ of Southern States."

VANDERBILT UNIVERSITY

Paul C. Bowers: "Tellurium, Atomic Weight."

SCIENTIFIC NOTES AND NEWS

The International Medical Congress, at its London meeting, awarded its three prizes as follows: The Moscow Prize to Professor

Charles Richet of Paris, for work on anaphylaxis; The Paris Prize to Professar A. von Wassermann, head of the Kaiser Wilhelm Institute for Experimental Therapy, for work on experimental therapy and on immunity; The Hungary Prize to Sir Almroth Wright of London, for work on anaphylaxis.

On the occasion of the International Congress of Medicine the Royal College of Surgeons conferred the honorary fellowship of the College on the following surgeons: Professor R. Bastianelli, Rome; Professor A. Bier, Berlin; Mr. F. D. Bird, Melbourne; Dr. G. W. Crile, Cleveland, U. S. A.; Dr. H. Cushing, Harvard; Dr. A. F. von Eiselsberg, Vienna; Dr. E. Fuchs, Vienna; Dr. H. Hartmann, Paris; Professor W. Korte, Berlin; Dr. W. J. Mayo, Rochester, U. S. A.; Dr. A. Monprofit, Paris; Dr. J. B. Murphy, Chicago; Dr. J. Nicolaysen, Christiania; Dr. F. J. Shepherd, Montreal, and Professor T. Tuffier, Paris.

Prof. W. C. McIntosh, F.R.S., professor of natural history in the University of St. Andrews, and director of the Gatty Marine Laboratory, has been elected president of the Ray Society in succession to the late Lord Avebury.

Mr. Harold Spencer Jones has been appointed chief assistant in the Royal Observatory, Greenwich.

Sir Rickman Godlee, president of the Royal College of Surgeons, has accepted the invitation to confer the fellowships of the American College of Surgeons at the first convocation of the institution which is to be held in Chicago, November 13. At this time it is stated that more than twelve hundred surgeons of the United States and Canada will receive fellowships.

Dr. James Algernon Temple, formerly dean of Trinity Medical College, and professor of obstetrics and gynecology in the University of Toronto, has received the degree of LL.D. from McGill University.

Major E. H. Hillis, F.R.S., president of the Royal Astronomical Society, has been given the honorary degree of doctor of science by the University of Durham.

The Raymond Horton-Smith prize at the University of Cambridge for 1913 has been awarded to F. A. Roper and F. S. Scales, who are adjudged equal for theses for the degree of Doctor of Medicine. Their subjects were: "Creatinine and creatin metabolism, especially in reference to diabetes," and "The electrocardiogram in diabetes."

The Baly medal has been awarded by the Royal College of Physicians to Dr. J. S. Haldane, F.R.S., reader in physiology at the University of Oxford.

The Paris Academy of Sciences has, as stated in the *Journal* of the American Medical Association, awarded two Montyon prizes of $500 each, one to Mme. Lina Negri Luzani for her studies on the so-called Negri bodies, discovered by herself and her late husband in the nervous system of rabid animals; the other to Dr. L. Ambard for his "Memoir on the Renal Secretion." The Barbier prize of $400 was shared between Drs. Jules and André Boeckel, on the one hand, for their work, "Fractures of the Cervical Spine without Medullary Symptoms," and Drs. Beurmann and Gougerot, on the other, for their volume on the sporotrichoses. The Argut prize of $240, a new biennial prize, intended to recompense the person who made a discovery curing a disease which previously could be treated only by surgery, thereby increasing the scope of medicine, was awarded to Drs. Robert Crémieu and Claudius Regaud for their work concerning the effects of the Roentgen ray on the thymus and the treatment of the thymus by roentgenotherapy. The Bréant prize of $20,000, intended for the discoverer of a cure for Asiatic cholera, was, of course, not awarded. Out of the interest on the fund, the academy awarded three prizes of $400, one to Dr. C. Levaditi for his work on acute epidemic poliomyelitis and acute infectious pemphigus; one to Drs. A. Netter and R. Debré for their work, "Cerebrospinal Meningitis," and one to Professor V. Babes for his treatise on rabies.

Dean Charles F. Emerson, of Dartmouth College, in conformity with the vote of the board of trustees passed several years ago,

limiting active service in the college faculty to the age of seventy years, has tendered his resignation as Appleton professor of natural philosophy and dean of the academic faculty and has been made dean emeritus. On graduation at Dartmouth in 1868 Mr. Emerson was appointed instructor in gymnastics in Dartmouth College and instructor in mathematics in the New Hampshire College of Agriculture and Mechanic Arts, then connected with Dartmouth College. He remained as tutor of mathematics in Dartmouth College four years and then was appointed associate professor of natural philosophy and mathematics, which title he held till 1878, when he was appointed Appleton professor of natural philosophy, as successor to Professor Charles A. Young, who had been called to Princeton; in 1878 he was appointed instructor in astronomy in addition to his professorship, which position he held till 1892. In 1893 he was made dean of the academic faculty, but continued teaching physics till 1899, after which he devoted all his time to the dean's work. He, therefore, has been connected with Dartmouth College continuously for forty-five years.

DR. LOUIS DUFESTEL, medical inspector of the Paris schools, and Dr. Felix Martel, inspector general of public instruction for the government of France, delegates to the Fourth International Congress on School Hygiene, which will be held in Buffalo on August 25 to 30, have arrived in New York.

THE commission appointed by the Russian government to study the question of the reorganization of the sanitary services of the empire has presented a report recommending the establishment of a ministry of public health.

UNIVERSITY AND EDUCATIONAL NEWS

MRS. JULIA L. BUTTERFIELD, of Cold Spring, N. Y., has bequeathed $100,000 to Union College. There are many other public bequests, including $150,000 for a hospital and $60,000 for a library in Cold Spring.

MIDDLEBURY COLLEGE, Vermont, has received $30,000 as the residuary legatee of the late Henry M. Barnum, a graduate of the college of the class of 1858.

THE memorial fund collected in honor of Alderman Beale, formerly vice-chancellor of the University of Birmingham, will be used to endow a chair of civil engineering. The amount collected now amounts to about $55,000.

BY the will of Baron Rendel, the sum of $25,000 is bequeathed to the University College of Wales, Aberystwith, of which he was president.

THE regents of the state of South Dakota have placed the government of the state university under the charge of a commission, consisting of the deans of the college of arts and sciences, the college of law, the college of medicine, the college of engineering and the college of music. Each of the deans will act as chairman of the board in rotation for one month.

DR. J. S. KINGSLEY, since 1892 professor of zoology in Tufts College, has been called to the University of Illinois as professor of zoology in charge of vertebrates. His address now is Urbana, Illinois.

DR. EDWARD O. SISSON, professor of education in Reed College and previously head of the department of education in the University of Washington, has been appointed commissioner of education for the state of Idaho.

DR. OTIS W. CALDWELL, associate professor of botany in the School of Education at the University of Chicago, has been appointed dean of University College at that institution, to succeed Mr. Walter A. Payne, who is now the university examiner.

DR. KARL F. MEYER, who has been a member of the veterinary faculty of the University of Pennsylvania since 1910 and director of the laboratories of the Pennsylvania State Livestock Sanitary Board, has resigned to take the professorship of bacteriology at the University of California. Dr. J. B. Hardenbergh, an instructor, succeeds Dr. Meyer as director of the state laboratories.

DR. GEORGE G. DAVIS, instructor in surgery at Rush Medical College, has obtained leave of absence for one year and sailed for Manila,

where he will serve as associate professor of surgery in the University of the Philippines.

A LECTURESHIP in fossil botany has been started at University College, London University, to which Dr. Marie Stopes has been appointed.

DISCUSSION AND CORRESPONDENCE

A SECOND CAPTURE OF THE WHALE SHARK, RHINEODON TYPUS, IN FLORIDA WATERS

IN SCIENCE for February 28, 1902, and again in Smithsonian Miscellaneous Collections, Vol. 48, 1905, Mr. B. A. Bean, of the United States National Museum, has recorded the coming ashore on the beach three miles north of Ormond, Florida, of an 18-foot specimen of the whale shark, *Rhineodon typus,* the skin and some parts of which are preserved in the National Museum.

Mr. Bean, in the above papers, and Dr. Gill, in SCIENCE for May 23, 1902, and May 19, 1905, have thoroughly and interestingly summarized almost all the scanty literature of this very large and very rare fish. The purpose of this note is to record the capture in Florida waters of another and much larger specimen than the one of which Mr. Bean has made note.

On June 1, 1912, Captain Charles Thompson, of Miami, Florida, captured near Knight's Key, Florida East Coast Railway Extension, what is probably the largest specimen of the whale shark ever taken by man. This monster is reported to have been 45 feet long, and 23 feet in circumference, and its weight is estimated at from 15,000 to 30,000 pounds.

While in Miami last summer I talked with Captain Thompson and saw the as yet unmounted skin. To one who has never seen a whale, the skin of this shark is inconceivably large. During the winter Captain Thompson has had the skin mounted, and photographs of it show that the work has been well done. Through his courtesy I have not only these photographs, but also one of the fish taken shortly after its capture.

During the winter I have been collecting data on *Rhineodon,* and during the coming summer I expect to be in Miami, at which time I purpose with Captain Thompson's permission to describe and to make careful measurements and to get from him full data concerning the capture of this great fish. This will be embodied in another and more extensive paper to be published later, in which will be included certain historical data not given in either Dr. Gill's or Mr. Bean's papers above referred to. In the meantime it seems well to call attention to this the second occurrence of the whale shark in the waters of the east coast of the United States.

As to the name of this fish, *Rhineodon typus,* the following statement may be made. The whale shark was first described from Table Bay, Cape of Good Hope, South Africa, by Dr. Andrew Smith in April, 1828. His description and figure were published in the *Zoological Journal* for 1829 under the name *Rhincodon typus.* However, this is clearly a typographical error, since the derivation is *rhine,* file + *odous* (*odont*), tooth. Muller and Henle (1838) first used the name given at the head of this paragraph, but later (1841) wrote it as it is commonly put, *Rhinodon typicus.* Dr. Gill, however (1905), goes back to the former spelling.

E. W. GUDGER
STATE NORMAL COLLEGE,
GREENSBORO, N. C.

"CARBATES"

TO THE EDITOR OF SCIENCE: In this age of method, accuracy and conciseness, we say sulphates instead of sulphurates; phosphates for phosphorates (better still, sulfates and fosfates); nitrates for nitrogenates; chlorates for chlorinates. Why should we not say *carbates* instead of carbonates?

We already say carbides instead of carbonides; why should we not follow the fashion consistently and say *carbates?*

We should then have the word carbation to mean the formation of carbates, leaving the word carbonation to refer to the development of carbon in a substance which would fittingly correspond to the present word carbonize, and so avoid a puzzling ambiguity.

Furthermore, the saving of time and printer's ink would amount to something in a word so often used.

J. E. Todd

University of Kansas

FROST IN CALIFORNIA

To the Editor of Science: In a recent issue of Science mention was made of the effect of a recent freeze upon the vegetation of southern California resulting in the destruction of many introduced varieties, including some very large trees.

The writer has been considerably interested in observing the effect of the freeze in this section, especially upon the different varieties of trees. Immediately following the freeze it did appear that many of the trees were probably killed. Peppers, eucalyptus, acacias and grevilleas among the larger trees suffered severely. Trees two to three feet in diameter and from twenty-five to thirty years old in some cases had the bark split clear to the wood almost from top to bottom of the tree. The bark turned black clear to the wood and great masses of it could be split off easily. Supposing that trees in such condition were certainly dead scores of them were cut down at once. Wiser counsel was to delay operations until opportunity was given to see what the outcome might be.

One can scarcely conceive what such a loss means to a community such as this, where shade means so much and where such magnificent results have been obtained. Some of our streets were lined with rows of eucalyptus from 75 to 150 feet high. Many of these have been cut down. Subsequent results show that delay in cutting and pruning was the wiser course in this instance, for, incredible as it may seem, many of the trees which had their bark split and turned black and loosened from the wood seem to have begun to develop a new bark, or in many cases the old bark seems to be reuniting with the wood and leaves and branches are being put forth.

I do not believe a single pepper of any size perished. In fact it seems to the writer that in their new coat of green they look brighter and fresher than ever.

Some of the acacias and grevilleas were probably killed, but I visited an acacia just recently which two weeks ago one would certainly have pronounced dead. The bark was split and loosened from the trunk and dry as tinder, the limbs were bare and brittle and dry enough to burn, but to my surprise when last I saw it here and there along the trunk the bark seemed to be reforming and green shoots a foot or more in length had grown. It looks as if with judicious pruning and care the tree might be made to live, though probably hideously deformed.

Perhaps the most surprising results are to be observed among the eucalyptus trees. Some varieties have suffered severely. The sugar gum (*E. cornocalyx*), lemon gum (*E. citriodora*), *E. robusta* and *E. callyophylla* suffered considerably. The blue gum. *E. globulus*, was injured in some localities. *E. amygdalina* was not injured at all.

The surprising feature in every case is the formation of a new bark or the rejuvenation of the old. Trees on which the bark was split and black and loosened from the wood now have bark green and full of sap and firmly united to the wood. The branches are for the most part dead, except the very large ones, and stand out bare and brown. The trunk and larger branches are covered almost from top to bottom with a new extremely dense growth of adventitious branches, thickly covered with leaves, giving the tree a peculiar fuzzy appearance.

Judging from the recovery of trees which two months ago were apparently lifeless, I believe it is safe to say that very few trees which were more than two or three years old and in a fairly healthy condition when the freeze came need have been cut. Judicious pruning will later be necessary.

S. A. Skinner

Redlands High School,
Redlands, Cal.

SCIENTIFIC BOOKS

Anleitung zur Kultur der Mikroorganismen. Von Ernst Küster. 2d edition. Leipzig and Berlin, B. G. Teubner. 1913.

Professor Küster, now of Bonn, prepared this compact little book of about 200 pages as a result of his long experience in training students at the Botanical Institute of Halle. It is neither a text-book nor a laboratory manual of the ordinary kind, including a definite course of study, but a reference compendium of technique including "the most important culture methods for all groups of microorganisms." The conception is an excellent one and Professor Küster has carried it out well.

The book is about equally divided between a general and a special part. The general part includes sections on water and glass, on liquid and solid media, sterilization, types of cultures, isolation and pure cultivation, inoculation, atmospheric conditions, temperature, light, evaporation, transpiration and cultivation in agitated or flowing media, detection and effects of waste products, operation of poisons, microbiochemical analysis and auxanography and the preservation of cultures. The special part includes sections dealing, respectively, with protozoa in general, with flagellata, with myxomycetes, with algæ, with fungi and with bacteria.

Two things are particularly notable about this book, its scholarly tone and the breadth of the field covered. Although the treatment is necessarily very condensed and no attempt is made to discuss with any fullness the philosophical problems involved, yet such fundamental questions as the effect of water upon glass, the physical and chemical characters of culture media and the study of waste products are discussed in a spirit which should prove enlightening to the American student who is too often superficially trained to use a few arbitrary methods without knowing or caring for underlying reasons. The other special virtue of the book is the attention to groups other than the commonly studied pathogenic forms. Special media are described, for example, for the cultivation of fat-splitting bacteria, the acetic acid bacteria, butyric acid bacteria, the nitrifying and denitrifying bacteria, the sulphur bacteria and the purple bacteria. Nine pages are devoted to the Protozoa, fifteen to the Algæ and thirty-nine to the Fungi. In general, citations of the literature dealing with technical procedures are full and valuable although American and English methods are neglected. It is strange to find no reference to the Hesse and Hiss and North media or to the extensive work done on standard methods of water examination. For German work, however, the book seems very comprehensive and as a reference source for dealing with any of the more unfamiliar groups of microbes it should prove invaluable in any laboratory.

C.-E. A. WINSLOW

AMERICAN MUSEUM OF NATURAL HISTORY

Catalogue of the Collection of Birds' Eggs in the British Museum. Vol. V., Carinatæ (Passeriformes completed). By W. R. OGILVIE-GRANT. 1912. Pp. xxiii + 547; Pls. XXII.

With the issue of the present volume the British Museum has brought to a successful conclusion the publication of another series of their splendid catalogues, which, while in most cases professing only to be records of their own collections, become in effect world records of the subjects covered. Ornithology has been especially favored with these reviews, the "Catalogue of Birds" (27 volumes, 1875–1895), the "Hand-list of the Genera and Species of Birds" (5 volumes, 1899–1909), and the "Catalogue of Birds' Eggs" (5 volumes, 1901–1912) being absolutely indispensable sources of reference to all working ornithologists who would make pretense to more than local studies. The first British Museum publication on birds' eggs was a small work by G. R. Grey, issued in 1852, but this was merely an enumeration of the eggs of British birds, and has long been obsolete. The national collection of eggs continued to grow, both by donation and purchase, and by 1900 had long passed the 50,000 mark, making it in many respects the foremost collection in the world. In preparing the exposition of this wealth of material the trustees of the museum were fortunate in securing the services of Mr. E. W. Oates, who is well known as the author of several of the bird volumes of the "Fauna of British India," and as the editor of the second

edition of Hume's "Nests and Eggs of Indian Birds." Mr. Oates prepared and published the first four volumes of the "Catalogue of Birds' Eggs," and had considerable manuscript for the final volume, when his death in 1911 brought the work to a close for a time. After considerable unavoidable delay Mr. Ogilvie-Grant has finally completed the undertaking with the present volume, which covers nineteen families of passerine birds, beginning with the white-eyes (*Zosteropidæ*) and ending with the crow-shrikes (*Striperidæ*). It treats of 1,117 species and over 19,000 specimens.

The nomenclature and systematic arrangement—as in previous volumes—follows that of Sharpe's "Hand-list," and in all cases reference is made to that work and to the "Catalogue of Birds," where the species was known when the latter work was published. There is also reference to the other more important works, especially those having figures of eggs. The descriptions appear to be carefully drawn with average measurements as well as mention of unusual or peculiar sizes and markings. The plates are beautifully executed and as the species treated are all of small size it has been possible to include something over four hundred figures. Altogether this is a highly successful completion of a notable undertaking.

F. H. KNOWLTON

Abhandlungen und Vorträge zur Geschichte der Naturwissenschaften. Vol. II. By Professor Dr. EDMUND O. VON LIPPMANN. Published by Veit and Co., Leipzig. 1913. Large 8vo. 491 pp.

Those scientific readers who enjoyed Professor Lippmann's "Essays and Addresses on the History of the Natural Sciences," which appeared in 1906, will welcome the appearance of this second companion volume.

Since the time of Kopp, whose monumental "Geschichte der Chemie" was printed just 70 years ago, no one in Germany has delved so deeply as Lippmann in the abstruse field of ancient chemical science, and certainly no one has better understood how to arouse an interest in matters which might seem to the general reader to lack importance.

The 32 papers in Vol. I. of the "Abhandlungen" dealt with such themes as the scientific and chemical knowledge contained in the works of Pliny, Dioscorides, Albiruni and Shakespeare; alchemistic poetry; the history of freezing mixtures, gunpowder, glass and the thermometer; biographical essays upon Marggraf, Achard, Mitscherlich, Leonardo da Vinci, Francis Bacon, Descartes and Robert Mayer; an account of two unpublished letters of Liebig; an address concerning Goethe's "Theory of Colors"; and other papers too numerous to mention.

In the new collection of "Abhandlungen und Vorträge," which has just been published, we note the same range and variety of subjects as were treated in the first volume. There are in all 36 additional papers in which we find discussed such topics as the chemical and scientific knowledge of the ancient Egyptians and Greeks and of the middle ages, as shown by the Ebers Papyrus, by the works of Plato and Aristotle and by the thirteenth-century "Régime du Corps" of Aldebrandino di Siena; the history of the water bath, the specific gravity spindle and the autoclave; the history of lead-soldering and of distillation and of the uses of petroleum as a fuel and of sugar as a preservative; the derivation and history of the terms "caput mortuum," alcohol, gas and potash; biographical papers upon Jean Ray, upon Alexander von Humboldt as the precursor of the theory of isomerism, and upon Liebig's relationship to Robert Mayer and the theory of conservation of energy; critical interpretations of obscure passages in Aristotle's Meteorology and in Goethe's Faust; and many other papers equally interesting and important. The pages of the book, as of the previous volume, are enlivened with anecdotes and curious bits of folklore, and it is difficult to recall another work of the kind which combines equally so much instruction and entertainment.

In these two volumes of the "Abhandlungen und Vorträge" additional surprises and pleasures are in store for those who have come to marvel at the many-sidedness of Professor

Lippmann's achievements. There are many who know the results of his practical work as director of the large sugar refinery at Halle, and of his researches in the laboratory, as comprised in his exhaustive two-volume treatise "Die Chemie der Zuckerarten," but there are fewer, perhaps, who know what he has done during leisure hours in the study along historical and cultural lines, as exemplified in his masterful book "Die Geschichte des Zuckers" and in these two volumes of scientific papers and essays. To be technologist, chemist, historian and scholar, and all surpassingly well, is a record of accomplishment such as few men have realized. Adapting a phrase from that ancient "father of science," Aristotle, of whose works Professor Lippmann is such an enthusiastic commentator, we may say: it is a record of accomplishment, "four-square and truly good."

C. A. BROWNE

SCIENTIFIC JOURNALS AND ARTICLES

THE July number (Vol. 14, No. 3) of the *Transactions of the American Mathematical Society* contains the following papers:

L. E. Dickson: "Proof of the finiteness of modular covariants."

R. D. Carmichael: "On transcendentally transcendental functions."

M. Fréchet: "Sur les classes V normales."

G. R. Clements: "Implicit functions defined by equations with vanishing Jacobian."

Dunham Jackson: "On the approximate representation of an indefinite integral and the degree of convergence of related Fourier series."

L. P. Eisenhart: "Certain continuous deformations of surfaces applicable to the quadrics."

THE concluding (July) number of volume 19 of the *Bulletin of the American Mathematical Society* contains: Report of the April meeting of the Society, by F. N. Cole; Report of the twenty-third regular meeting of the San Francisco Section, by W. A. Manning; "The total variation in the isoperimetric problem with variable end points," by A. R. Crathorne; "A note on graphical integration of a function of a complex variable," by S. D. Killam; "The unification of vectorial notation," by E. B. Wilson; "Shorter Notices": Kowalewski's Grundzüge der Differential- und Integralrechnung, by R. L. Borger; Vivanti-Cahen's Fonctions polyédriques et modulaires, by G. A. Miller; Markoff-Liebmann's Wahrscheinlichkeitsrechnung, Carvallo's Calcul des Probabilités et ses Applications, and King's Elements of Statistical Method, by A. C. Lunn; "Notes"; "New Publications"; Twenty-second Annual List of Published Papers; Index of Volume XIX.

THE RUTHERFORD ATOM

To explain the observations made by Geiger and Marsden[1] on the scattering of α particles through large angles by metal foils, Rutherford[2] suggested that in such cases the deflection of each ray was due to an intimate encounter with a single atom of the matter traversed. It was necessary to assume that the positive charge is highly concentrated in a very small volume at the center, surrounded by an equal amount of negative electricity distributed throughout the remainder of the volume of the atom. To compare the theory with experiment, suppose we consider the effect of allowing a narrow pencil of α rays to strike a thin metal foil from a direction perpendicular to its surface. The probable number of reflected or deflected rays which may be expected each second to strike any given square centimeter of a spherical screen whose center of curvature is the point of bombardment, was shown by Rutherford to be, according to his theory,

$$P = \frac{Qnt}{4r^2}\left(\frac{NeE}{mu^2}\right)^2 \operatorname{cosec}^4 \frac{\phi}{2},$$

where:

Q = number of α rays striking the foil per second;

nt = number of atoms in the foil per unit area;

r = radius of the spherical screen;

ϕ = angle between the radius vector to the area and the direction of the striking beam of rays; or the angle of deflection;

Ne = central charge of the bombarded atom;

[1] *Proc. Roy. Soc.*, 82A: 495, 1909; 83A: 492, 1910; *Manchester Lit. and Phil. Soc. Proc.*, 1910.

[2] *Phil. Mag.*, 21: 669, 1911.

E = charge of an a ray;
m = mass of an a ray;
u = velocity of an a ray.

More recently, Geiger and Marsden[3] have performed a very thorough series of experiments which verify this formula, within an experimental error of about 20 per cent., for wide variations of nt, u and ϕ. In addition, by testing foils of various metals they found that P is proportional to the square of the atomic weight of the bombarded metal, other things being the same. Their experiments prove, then, that, for gold, platinum, tin, silver, copper and aluminium,

$$P = K\frac{Qnt}{4r^2} \cdot \left(\frac{A}{u^2}\right)^2 \cdot \operatorname{cosec}^4 \frac{\phi}{2},$$

where A is the atomic weight. The striking agreement of their results with the predictions of the Rutherford theory certainly lend it great support. It surely deserves careful consideration to see whether other conclusions from it may be tested experimentally and whether other atomic phenomena may be explained by it. Assuming the correctness of the Rutherford formula, Geiger and Marsden computed from an absolute determination of Q and the other quantities involved, the positive charge which must be assumed to be concentrated at the centers of the atoms of the metals investigated; and they found that it is, within 20 per cent., numerically equal to half the atomic weight in each case times the charge of an electon; that is,

$$N = \frac{A}{2}(1 \pm .2);$$

a most important conclusion, if true.

Evidently, since hydrogen can not have as a nucleus a charge of $+\frac{1}{2}e$, it must be an exception; the above law can not hold for all the elements. In this connection some experiments of Kleeman[4] on the relative ionization in various gases, are of interest. He found that the ionization per cubic contimeter of various compound gases by a given agent can be predicted from the ionization by the same agent of the separate elements composing the compounds; that is, ionization is roughly an additive, atomic property. From the results obtained with a number of simple and compound gases, he computed approximately the atomic ionization for various elements as given in the following table:[5]

Agent	Atomic Ionization		Atomic Weight	Atomic Ionization / Atomic Weight	
	β Rays	γ Rays		β Rays	γ Rays
H (gas)	.08	.08	1	.082	.080
C	.46	.46	12	.038	.038
N	.47	.45	14	.034	.032
O	.58	.58	16	.036	.036
S	1.60	1.60	32	.050	.050
Cl	1.44	1.44	35.5	.040	.040
Br	2.67	2.81	80	.033	.035
I	4.10	4.50	127	.032	.035

While other factors enter, such as the valence or the position of the elements in the periodic table and chemical linkage with other atoms, atomic ionization seems to depend primarily on the atomic weight, which is probably proportional to the number of electrons in the atom. The fact that hydrogen has approximately twice the atomic ionization which should correspond to its atomic weight, suggests that it may have twice as many electrons in proportion to its atomic weight as the other elements—in agreement with the above conclusion from the Rutherford theory. It is also noteworthy that canal ray deflection experiments performed by Sir J. J. Thomson, Wien, Koenigsberger and others have given no evidence for the existence of doubly charged hydrogen atoms in a discharge tube, whereas doubly charged atoms of other gases are often present. This would tend to confirm the conception of the hydrogen atom as a small positive nucleus with a single electron revolving as a satellite around it.

As for helium, we may suppose, perhaps, that a particles, since they are projected from radioactive substances with such enormous velocities, are stripped of all satellite electrons; that a particles are merely positive nuclei with a charge of $+2e$. If so, the number of satellite electrons in the neutral helium

[3] *Phil. Mag.*, 25: 604, April, 1913.

[4] *Proc. Roy. Soc.*, 79A: 220, 1907; 83A: 530, 1910.

[5] *Proc. Roy. Soc.*, 79A: 220, 1907.

atom must be two, or half its atomic weight—also in agreement with the Rutherford theory.

So far so good. But when we consider the hydrogen and helium spectra, we get into difficulty immediately. Stark, Fischer and Kirschbaum,[6] from a recent careful study of the Stark-Doppler effect in connection with helium canal rays, conclude that the series of single lines which Runge and Paschen ascribe to "parhelium" are emitted by the doubly charged helium atom. Also, according to Stark's hypothesis (which, though not proved, yet seems probable from certain indirect evidence) the hydrogen series lines are emitted by the single charged hydrogen atom. Now, both the "parhelium" and the hydrogen series lines show the normal Zeeman effect and therefore can not be emitted by systems devoid of vibrating electrons. Stark's hypothesis therefore demands a more complex atom; it is incompatible with the Rutherford theory as far as hydrogen and helium are concerned.

Also, recent experiments seem to associate the compound spectrum of hydrogen with the positively charged molecule. It is of course enormously complex. Many of its lines show a normal Zeeman effect, others an abnormal effect, others apparently no effect at all.[7] How such a spectrum can be due to the vibrations of a single electron around two positive nuclei seems inconceivable.

Certainly the Rutherford atom seems much too simple to explain these spectral phenomena, though perhaps these and other objections may be overcome. Is this conception of the atom the only one which leads to the expression for the distribution of scattered α rays which Geiger and Marsden have so thoroughly verified? If possible, the scattering effect of hydrogen should be tested. Perhaps this might be done by the use of a compound of hydrogen or liquid hydrogen. Such experiments on the scattering of α and β rays seem our most promising means of securing more exact knowledge of the actual structure of atoms; but the conceptions thus suggested must explain or be in accord with a wide variety of atomic phenomena before they can expect general acceptance.

GORDON S. FULCHER
UNIVERSITY OF WISCONSIN,
June 27, 1913

[6] *Ann. d. Phys.*, 40: 499, March, 1913.

[7] Dufour, *Annal. chim. phys.* (8), 9: 413, 1906.

NOTES ON ENTOMOLOGY

ECONOMIC entomologists will welcome the appearance of a new monthly journal—*The Review of Applied Entomology.* It is published in London (Dulau & Co.) and issued in two series: series *A*, agricultural; series *B*, medical and veterinary. It consists almost wholly of reviews of other works, or reports sent in by various investigators. The journal is supported by the Imperial Bureau of Entomology, and Guy A. K. Marshall is the editor, while a series of distinguished entomologists and naturalists form a committee of management. The parts so far issued average 32 pages for series *A*, and 20 pages for series *B*. In series *B* there are references to new species in certain groups of general medical importance, as mosquitoes and Tabanidæ.

THE perfection of preservation of the amber insects has made them a most attractive field of study. Most fossil insects are so discouragingly imperfect, that a knowledge of the actual structural details of some prehistoric insects is a most welcome contribution to the phylogeny of the group. And when this is brought out by so able a specialist in the group as by Dr. G. Ulmer in his "Amber Trichoptera"[1] we can place confidence in the interpretations. Probably the most important point is that the Limnephilidæ, now a dominant family in northern Europe, is lacking in amber, although all other families are represented, and the Sericostomatidæ by many remarkable genera. The presence of a few genera such as *Ganonema, Marilia* and *Triplectides,* now occurring in tropical regions, give one the impression (probably erroneous) of a warmer climate. Besides describing in detail the genera (56) and species (152) known from amber Dr. Ulmer presents many

[1] "Die Trichopteren des Baltischen Bernsteins," Schriften Physik.-Okonom. Gesellsch. Königsberg; Beiträge zur Naturkunde Preussens, Heft 10; 380 pages, 480 figs., 1912.

new ideas in their classification and their bearing on the system of recent caddice-flies. It is thus a work of great use to all who study these insects.

M. E. Guyenot is the author of a morphological study on the papillæ of the proboscis of Lepidoptera.[3] These occur on all Lepidoptera, but are variable in number and slightly in structure. The ordinary form is a subcylindric or fusiform process with the tip margined by a ring or a row of spinules. From the middle of the tip arises a short cylindric process or a spine. This process contains a nerve extending back through the main part of the papilla. Those on different parts of the proboscis vary in length and in development of spinules. Sometimes the papillæ are ribbed on the outside or with whorls of spinules. The author reaches no conclusion as to their function, but criticizes the tactile theory of Breitenbach.

The increasing interest in medical entomology results in new treatises thereon; one of the most recent is by Dr. E. A. Goeldi.[3] It is a very good and well-illustrated compilation on the subject. There are three principal chapters: I., Stinging, Biting and Urticating Insects; II., Parasitic Insects; III., Insects as Disease-carriers. Mites and other arachnids are included, and also the life cycle of the various Hæmatozoa.

The stable fly, because of its biting habits and abundance, has been suspected of transmitting several diseases. In the Philippines it has been accused of carrying surra. Recently Dr. M. B. Mitzmain has investigated the matter.[4] He conducted a long series of experiments, and only when the fly had bitten several hundred times was there a case of transmission. The trypanosome does not pass through any development in the fly, and so rarely is the fly an accidental vector that it may be absolved from connection with the disease.

Keilin has lately noted[5] that among the higher Diptera those forms that have on the ventral wall of the pharynx longitudinal chitinous folds are saprophagous, while the parasitic (including plant-parasites) and predaceous forms do not have these folds. It is, therefore, possible by examination of structure to learn the habits of certain Diptera. Thus *Graphomyia*, supposedly coprophagous, is probably carnivorous, and feeds on the other larvæ present in its habitat. Later Keilin shows that the Trypetidæ living in fruits have these folds which would indicate that they live on tissue attacked by a microorganism, introduced perhaps with the egg.

The first volume on the flies of India is by Mr. Brunnetti,[6] who for some years has resided in that country. Forty-four pages are devoted to an introduction including directions for the preparation of specimens for the cabinet. Over 425 species are described, a very large number being new, or recently described by the author. The Tipulidæ (with Ptychopterinæ) occupy a large part of the work. The genera are mostly the same or similar to our own, and only a few are described as new. There is also a glossary of terms used in Dipterology.

Many entomologists will be interested in the new color manual[7] of Dr. R. Ridgway. On the fifty-three colored plates are 1,115 named colors, and in text an alphabetical list of colors. A shorter series, if made available to all entomologists, would do much to standardize descriptions.

Nathan Banks

[2] "Les papilles de la trompe des Lepidoptères," *Bull. Sci. France Belg.*, XLVI., pp. 279–343, 3 pls. (1913); many text figures.

[3] "Die sanitarisch-pathologische Bedeutung der Insekten und verwandten Gliedertiere, namentlich als Krankheits-Erreger und Krankheits-Uberträger," 155 pages, 171 figs., 1913, Berlin, Friedländer u. Sohn.

[4] "Rôle of *Stomoxys calcitrans* in the transmission of *Trypanosoma evansi*," *Philipp. Journ. Sci.* (B), Vol. VII., pp. 475–518, 1913, 5 pls.

[5] "Structure du pharynx au fonction du régime chez les larves de Diptères cyclorhaphes," *C. R. Acad. Sci. Paris*, t. 155, pp. 1548–1551, 1912.

[6] "The Fauna of British India, including Ceylon and Burma. Diptera Nematocera (exclusive of Chironomidæ and Culicidæ)," 581 pages, 7 pls., 1912.

[7] "Color Standards and Color Nomenclature," Washington, 1912, 43 pages, 53 col. plates.

SPECIAL ARTICLES

PRELIMINARY NOTE ON BIRDS AS CARRIERS OF THE CHESTNUT BLIGHT FUNGUS[1]

STATEMENTS have been made by various writers that birds play a part in the dissemination of the chestnut blight fungus. Murrill[2] mentions the possible relation of birds to the disease and writes as follows: "Millions of minute summer spores emerge from day to day in elongated reddish-brown masses to be disseminated by the wind and other agencies, such as insects, birds, squirrels, etc.," also,[3] "every bird and insect that rests upon an infected spot is liable to carry the spores upon its feet or body to other trees." A few years later Mickleborough[4] mentions birds as carriers of blight spores. He says: "The minute spores are carried by wind, on the feathers of birds and the fur of squirrels." Still later Metcalf and Collins[5] say, "there is strong evidence that the spores are spread extensively by birds, especially woodpeckers." Various writers have emphasized the fact that woodpeckers frequent chestnut trees in search of insects. Fulton[6] states in a report on field work done at Orbisonia, Pa., by R. C. Walton that "woodpecker work was noted in about one tenth of the oldest lesions," but offers no conjecture as to the part played by birds, in the dissemination of the blight.

Stewart[7] says, "undoubtedly the spores are carried long distances by birds, especially woodpeckers, which visit the diseased trees, seeking borers, in the tunnels of which most of the infections occur." This statement is based on the report of Metcalf and Collins previously referred to, and is discredited by Fisher,[8] who brings out the point that this and similar statements are not based on positive evidence. There are numerous popular articles which also accuse birds of being instrumental in the spread of the blight, but these as well as the statements already quoted are based entirely on circumstantial evidence.

The first serious attempt to determine whether birds actually do carry the spores of the blight fungus were made by the field pathologists of the Pennsylvania Commission during the summer of 1912.[9] They report the testing of twenty birds as follows: eight downy woodpeckers, three creepers (kind not mentioned), two hairy woodpeckers, four flickers, and three blue jays, all with negative results. No suggestions will be made at present to account for their *negative* results, but our positive results will be presented.

During the past spring the writers have devoted considerable time to the testing of birds as carriers of the blight fungus. The first accurate analyses were made in February and the work was continued until about the middle of May. Thirty-six birds belonging to nine different species have been examined.[10] The birds were shot in the field and placed at once in sterile paper sacks for transport to the commission laboratory at the University of Pennsylvania, where the quantitative analyses were completed. Most of the birds tested were shot at either West Chester, or at Martic Forge, or in the vicinity of these places, since we wished to use the rainfall records which we were keeping at those stations. The method of making an analysis was as follows: A flask containing 100 c.c. of sterile water was emptied into a sterile moist chamber, and the bird

[1] Investigations conducted in cooperation with the Pennsylvania Chestnut Tree Blight Commission.

[2] Murrill, W. A., "A Serious Chestnut Disease," *Jour. N. Y. Botanical Garden*, 7: 146, 1906.

[3] *Ibid.*, 152.

[4] Mickleborough, J., "A Report on the Chestnut Tree Blight," Pa. Dept. of Forestry, unnumbered bulletin, p. 11, 1909.

[5] Metcalf, Haven B., and Collins, J. Franklin, "The Control of the Chestnut Bark Disease," U. S. Dept. Agr., Farmers' Bul. No. 467: 9, 1911.

[6] Fulton, H. R., "Recent Notes on the Chestnut Bark Disease," Harrisburg Conf. Rep., p. 56, 1912.

[7] Stewart, F. C., "Can the Chestnut Bark Disease be Controlled?" Harrisburg Conf. Rep., p. 43, 1912.

[8] Fisher, A. K., Harrisburg Conf. Rep., p. 103, 1912.

[9] Anderson, P. J., Elza, W. H., and Babcock, D. C., "Field Studies on the Dissemination and Growth of the Chestnut Blight Fungus," Bulletin Pennsylvania Chestnut Tree Blight Commission 3: (in press), 1913.

[10] The birds used in this work were shot by Mr. C. E. Taylor, who was formerly employed by the Pennsylvania Chestnut Tree Blight Commission.

to be tested was placed in this vessel, and its feet, tail and head and bill scrubbed vigorously with a sterile brush. The bird was then removed and the wash water shaken to secure a uniform suspension. By means of a sterile pipette, one cubic centimeter of this wash water was then added to a second flask of sterile water to make 100 c.c. Using another sterile pipette measured quantities (1 c.c. or fraction) were removed from this dilution flask and plated out in Petri dish cultures in 3 per cent. dextrose agar, plus 10. The plates were incubated as nearly as possible at 25° C. and the colonies suspected of being the blight fungus were marked at the end of four days and their later development followed. Whenever necessary they were transferred to other culture plates to verify the diagnosis. A determination was made of the number of bacterial and yeast colonies, the total number of fungous colonies, the number of colonies of the chestnut blight fungus and the number of species of other fungi represented. The original wash water was retained and centrifuged later for microscopic examination. The entire operation was carried out in a culture room with special care to exclude any sources of error. The following is a summary of results obtained up to May 12.

Name of Bird	No. Tested	No. Carrying Spores of Blight Fungus	Max. No. Spores of Blight Fungus Carried by Single Bird
Hairy woodpecker (*Dryobates villosus villosus*)	3	0	0
Downy woodpecker (*Dryobates pubescens medianus*)	16	13	757,074
Flicker (*Colaptes auratus luteus*)	1	0	0
Nuthatch (*Sitta carolinensis carolinensis*)	2	1	5,655
Golden-crowned kinglet (*Regulus satrapa satrapa*)	1	1	6,565
Sapsucker (*Sphyrapicus varius varius*)	2	2	7,502
Brown creeper (*Certhia familiaris americana*)	2	1	254,019
Black and white creeper (*Mniotilta varia*)	7	0	0
Junco (*Junco hyemalis hyemalis*)	2	1	10,000
Total	36	19	

The analyses show a direct relation between periods of maximum rainfall and the maximum numbers of spores obtained. During the time covered by the analyses there were four periods of heavy rainfall. The highest numbers of blight spores were invariably obtained from birds shot two to four days after a period of considerable rainfall. The maximum numbers for the four periods are as follows:

Date	No. Days after Rain	Name of Bird	No. Spores Obtained
3/19	4	Downy woodpecker	109,022
3/29	2	Downy woodpecker	757,074
4/18	4	Brown creeper	254,019
4/30	2	Downy woodpecker	624,341

The number of species of fungi besides *Endothia parasitica* carried by the birds varied from four to fourteen as determined from the cultures. A microscopic examination of the centrifuged sediments showed, however, a much larger number, which could be detected by form, size and coloration of the spores. The total amount of wash water for each bird was centrifuged in 10 c.c. quantities and the final amount (about 2 c.c.) containing all the sediment was given a thorough microscopic examination. In sediment from birds which had yielded the high number of spores of the blight fungus it was very easy to find the *pycnospores*, but in those giving the low results the pycnospores were located with more difficulty, but they could always be found. In no cases were any ascospores found in the sediment. During the time covered by our analyses there were only five periods when ascospores were expelled in the field. The first was on March 21 and the last on April 28. The microscopic examinations substantiate the results obtained by the cultures, since the rate of development of the colonies indicated their origin from pycnospores.

To summarize, our results show that the spores of the blight fungus carried by birds are pycnospores and not ascospores and that the maximum numbers are being carried during the few days following rain periods. We are also led to the conclusion that the pycnospores carried are *brushed off* from either the normal or

diseased bark or both in the movements of the birds over these surfaces. This conclusion is supported by the fact that the birds tested were not carrying ascospores; that we have no evidence that ascospores are washed down the trees during the winter and spring months;[11] also that following a rain period pycnospores are to be found in abundance on the healthy bark below blight lesions.

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THE RELATION BETWEEN ABNORMAL PERMEABILITY AND ABNORMAL DEVELOPMENT OF FUNDULUS EGGS

In a previous paper[1] the suggestion was made that certain abnormalities in *Fundulus* embryos are caused by increase in permeability since osmotic pressure is not the cause and so many *different* substances have the *same* effect. It was found that the normal egg in distilled water or a "balanced" salt solution is impermeable to salts (Appendix II.). The egg appeared to be impermeable to water also, since enormous osmotic changes have no effect on it. The egg was found to contain nearly three times as much ash as sea water. The greater part of the ash is insoluble, but some of it may have been rendered so by the ashing. However, the soluble ash (3.18 per cent.) is as great as the total salts (2.84–3.29 per cent.) in the local sea water. And yet the egg develops normally, with little or no change in volume, in distilled water or in sea water that is evaporatd to one half its volume, suggesting impermeability to water. The fact that the eggs dry up when exposed to air may be taken to indicate an increase in permeability to water, due to drying of the superficial layer or plasma membrane.

[11] Heald, F. D., and Gardner, M. W., "Preliminary Note on the Relative Prevalence of Pycnospores and Ascospores of the Chestnut Blight Fungus during the Winter," Science, N. S., 37: 916–917, 1913.

[1] McClendon, *Am. Jour. Physiol.*, 1912, XXIX., p. 290.

In the same paper some preliminary chemical studies of the permeability were described, and the view advanced that the egg is normally impermeable to Mg ions, but since Mg was found to diffuse out of the eggs in a pure NaCl solution, this solution may have increased the permeability to Mg (p. 296). Only one experiment to test the permeability to anions was described. $MgSO_4$ solution was used, with negative results. However, the $MgSO_4$ contained too large a trace of chloride to make it possible to detect a very small diffusion of chloride from the eggs.

During the present season I was able to obtain especially pure salts, and have observed diffusion of both anions and kations from the eggs in pure solutions of these. The monstrosities produced in unbalanced salt solutions have also been studied. The experiments support the following generalizations:

1. Any solution of one or more of the salts of sea water, which is sufficiently unbalanced by other salts, *i. e.*, has a certain excess of some one kation, produces a number of types of monstrosities in *Fundulus* eggs. The types of monsters produced by the excess of one kation (*e. g.*, Na) are the same as those produced by any other (*e. g.*, K, Ca or Mg). Thus a qualitatively *specific action of a salt or ion does not exist.*

2. *These unbalanced salt solutions cause an increase in the permeability of the egg to salts.* This conclusion is based on the following data: The eggs in distilled water or in van't Hoff's solution (made with nitrates) lose no salts or ions that can be detected, except the ions of carbonic acid. On the contrary, the eggs give out salts or their ions in a mixture of NaCl and KCl or in pure solutions of the following salts: NaCl or nitrates of Na, K, Ca or Mg *in concentrations that do not kill the eggs* during the experiment. If the eggs are killed a more rapid diffusion takes place. The methods used will be published elsewhere.

J. F. McClendon
U. S. Bureau of Fisheries,
Woods Hole, Mass.,
July 25, 1913

SOCIETIES AND ACADEMIES

NEW YORK ACADEMY OF SCIENCES. SECTION OF GEOLOGY AND MINERALOGY

THE section was called to order by the chairman, Professor J. Edmund Woodman, immediately on adjournment of the business meeting of the academy, at 8:20 P.M., March 3, 1913, at the usual meeting-place in the American Museum of Natural History. Some thirty-five members and visitors were present.

After calling President McMillan to the chair, Professor Woodman presented the subject of "The Interbedded Iron Ores of Nova Scotia." The field evidences were elaborately illustrated by lantern views and hand specimens—some half a hundred of each. The net results seemed to warrant a modified form of the replacement theory for the explanation of these deposits.

Professor Kemp commented on the interesting new evidence in the light of the older body of data which seems to argue somewhat in opposition to the findings of Professor Woodman, as presented by workers in other regions. He concluded with an invitation for remarks by Professor Van Ingen, of Princeton University, a former officer in the New York Academy of Sciences. Professor Van Ingen stated that the results of his investigations into the iron ore deposits of Newfoundland were as yet inhibitive, but that he had found extremely probable evidence of Paleozoic faunal connection between Newfoundland and certain European localities.

ON adjournment of the usual business meeting of the academy at 8:25 P.M., April 7, 1913, Chairman J. Edmund Woodman called to order the joint meeting of the Section of Geology and Mineralogy and the New York Microscopical Society in the regular meeting-place in the American Museum of Natural History. Sixty-six persons were present.

On a reading by Dr. E. O. Hovey, recording secretary of the New York Academy of Sciences, of the invitation extended the academy by the Twelfth International Geological Congress, which meets in August, 1913, at Toronto, Canada, the following delegates were nominated by the section: Professors J. J. Stevenson, J. Edmund Woodman, James F. Kemp and Charles P. Berkey.

The paper of the evening, on "The Genesis of Certain Paleozoic Interbedded Iron Ores," was presented by Mr. R. B. Earle. Some 50 lantern slides showing both microscopic and gross structures and textures were presented, several being projected by the splendid apparatus of the New York Microscopical Society. About 125 hand specimens were also exhibited. Mimeographic copies of a summary of the paper were available for all present.

Mr. Earle's work has been furthered by a grant made by the New York Academy of Sciences some months ago. He has visited many exposures along the Paleozoic bedded ore region of the Appalachians, and compared notes with many students of that problem, finding that ninety per cent. of them agree with Smyth's theory, as modified after James Hall, giving the ores a contemporaneous sedimentary origin.

Certain evidences underground seemed to Mr. Earle to discredit the theory of residual origin; inadequate source for the iron seemed to argue against that of replacement according to processes formerly suggested. While certain cavernous consolidations containing non-ferruginous sand and some granules coated with calcite argue for replacement, he finds evidence in the relatively impervious strata above and below the somewhat permeable iron formation for a different form of circulation of the iron-bearing solutions than previously appealed to, namely, artesian. He pointed out that not merely the Clinton horizon, but various other geologic epochs in the Appalachians carry iron formations of similar origin.

Professor Kemp congratulated the speaker on his excellent presentation, and suggested rather reasonable sources of iron from bicarbonates carried into estuaries, there deposited as hydrous oxides, later to be dehydrated. He inquired as to oxidation at such great depths by artesian waters, as to the sources of iron, and thought that stagnation rather than circulation would be probable under the conditions as presented.

Dr. George F. Kunz suggested that present conditions along saline shores, inland seas, and even in fresh-water bogs might be analogous to those during deposition of the Paleozoic ores, and cited the association of the Syracuse salts and Clinton ores, as well as the Swedish bog ores.

Professor J. J. Stevenson called attention to certain fragments of the ores in the superjacent sediments, and to certain points bearing on leaching from sediments above. He thinks the whole truth is not told by the new theory.

The lateness of the hour precluded further discussion at this meeting, so that on motion of Professor Berkey additional time for consideration of the paper was granted place on the program of the next monthly meeting.

Dr. Hovey read by title a paper by Mr. Warren

M. Foote on "Factors in the Exchange Value of Meteorites."

The section was called to order at the usual meeting-place in the American Museum of Natural History by the chairman, Professor J. Edmund Woodman, at 8:25 P.M., May 5, 1913. Thirty-five persons were present.

Following the acceptance of the resignation of Charles T. Kirk, secretary of the section, Dr. A. B. Picini was recommended to the council of the academy for election to that office.

The following papers were read by title:

"A Contribution to the Geology of the Wasatch Mountains, Utah," by Mr. Ferdinand F. Hintze, Jr.

"Physiographic Studies in the Allegheny Plateau, Particularly along its Western Margin in Ohio and Kentucky," by Dr. Jesse E. Hyde.

"A Limestone Dike in Southern Ohio," by Dr. Jesse E. Hyde.

Then was continued the discussion of Mr. R. B. Earle's paper on "The Genesis of Certain Paleozoic Interbedded Iron Ores," presented at the April meeting.

Professor Kemp was invited to open the discussion, and inquired: (1) If there are not other oolites than the Clinton horizon which have been replaced by iron? (2) Would there not be stagnation of the water below the vadose region?

Mr. Earle referred number (1) to his colleagues, and replied to number (2) by saying that the "impervious" beds are not wholly so, but only more so than their contained loosely aggregated beds—the iron formations. He believes, moreover, that there have been fluctuations of the ground water level. He observed also, in reply to Professor Stevenson's inquiry at the last meeting, that the fragments in the superjacent beds are not directly in contact with the iron formation, and cited replacement of pebbles and not of their matrix, a feature also described in U. S. Geol. Survey Bull. 430.

Professor Woodman, in comparing with the iron ores of Nova Scotia, showed that various materials are replaced, and that there are isolated granules of iron ore contained in a matrix of mud, an observation similar to those of Mr. Earle. Professor Woodman maintains that the cavernous consolidations are unexplained by any syngenetic theory; also that there is either partial replacement or partial leaching in various regions. He finds, incidentally, that the materials typically replaced are siliceous rather than calcareous.

Professor Grabau discussed the iron ore deposits of Tennessee, stating that they are replaced fossils which have not been rolled. He observed that the deposits in Wisconsin have pebbles with surfaces resembling desert varnish, and that the pebbles lie at all attitudes. There are no fossils; the beds are lens-shaped—apparently cross-bedded by wind action. There is little cementing silica. He believes that the original sediments in these instances have been replaced by iron.

Dr. A. B. Picini followed with observations on the chemistry of iron ore deposition, showing that there is yet too little known of such processes in nature to prophesy certainly as to oxidizing or deoxidizing conditions underground. He referred to Van Bemmelen's results, which show that the yellow oxides of iron deposited chemically are non-colloidal, while the red are colloidal.

Mr. A. P. Picini gave account of experiments still under way in which he has already secured some replacement in a few hours by passing iron in carbon dioxide solution through porous calcite and silica at about 10 atmospheres.

Professor A. W. Grabau's paper on "Irrational Stratigraphy: The Right and Wrong Way of Reconstructing Ancient Continents and Seas" was of the nature of a critique. It was illustrated with paleographic maps by Schuchert, Ulrich, Willis, and Chamberlin and Salisbury. The thesis indicated that these maps are too often based on paleontology alone to the neglect of the sediments themselves—especially their origin. There are sometimes arms of the sea across areas where the origin of a bed of conglomerate would be expected. Erosion was here left out of the question, and a "stratigraphic hash" was the result. Further, basins where crinoids, corals, brachiopods, etc., are found are mapped too small.

Questions followed by Professor Woodman on the probable width of Appalachia, by Dr. C. A. Reeds on the connection between the Atlantic and Pacific in Silurian time, on the origin of the Silurian salts, and on the position of the present Atlantic deep where once Appalachia, a considerable continent, is supposed to have lain.

Professor Grabau thinks Appalachia may partly have lain where the Atlantic coastal plain now is, and did not extend over to the present Atlantic deep; that is, was perhaps less than 500 miles wide. The Silurian salts he thinks have originated while the Taconic land mass lay to the eastward in such a position as to cut off moisture-bearing winds.

Charles T. Kirk,
Secretary of Section

SCIENCE

FRIDAY, AUGUST 29, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

A MECHANISTIC VIEW OF PSYCHOLOGY[1]

TRADITIONAL religion, traditional medicine and traditional psychology have insisted upon the existence in man of a triune nature. Three "ologies" have been developed for the study of each nature as a separate entity—body, soul and spirit; physiology, psychology, theology; physician, psychologist, priest. To the great minds of each class, from the days of Aristotle and Hippocrates on, there have come glimmerings of the truth that the phenomena studied under these divisions were interrelated. Always, however, the conflict between the votaries of these sciences has been sharp, and the boundary lines between them have been constantly changing. Since the great discoveries of Darwin, the zoologist, biologist and physiologist have joined hands, but still the soul-body-spirit chaos has remained. The physician has endeavored to fight the gross maladies which have been the result of disordered conduct; the psychologist has reasoned and experimented to find the laws governing conduct; and the priest has endeavored by appeals to an unknown god to reform conduct.

The great impulse to a deeper and keener study of man's relation, not only to man, but to the whole animal creation, which was given by Darwin, has opened the way to the study of man on a different basis. Psychologists, physicians and priests are now joining hands as never before in the great world-wide movement for the betterment of man. The new sci-

[1] Paper read before Sigma Xi, Case School of Science, Cleveland, Ohio, May 27, 1913.

ence of sociology is combining the functions of all three, for priest, physician and psychologist have come to see that man is in large measure the product of his environment.

My thesis to-night, however, will go beyond this common agreement, for I shall maintain, not that man is in *large measure* the product of his environment, but that environment has been the actual *creator* of man; that the old division between body, soul and spirit is non-existent; that man is a unified mechanism responding in every part to the adequate stimuli given it from without by the environment of the present and from within by the environment of the past, the record of which is stored in part in cells throughout the mechanism, but especially in its central battery—the brain. I postulate further that the human body mechanism is equipped first for such conflict with environment as will tend to the preservation of the individual and second for the propagation of the species, both of these functions when most efficiently carried out tending to the upbuilding and perfection of the race.

Through the long ages of evolution the human mechanism has been slowly developed by the constant changes and growth of its parts which have resulted from its continual adaptation to its environment. In some animals the protection from too rough contact with surroundings was secured by the development of an outside armor; in others noxious secretions served the purposes of defense, but such devices as these were not suitable for the higher animals or for the diverse and important functions of the human race. The safety of the higher animals and of man had to be preserved by some mechanism by means of which they could become adapted to a much wider and more complex environment, the dominance over which alone gives them their right to be called "superior beings." The mechanism by the progressive development of which living beings have been able to react more and more effectually to their environment is the central nervous system, which is seen in one of its simplest forms in motor plants, such as the sensitive plant and the Venus fly trap, and in its highest development only in the sanest, healthiest, happiest and most useful men.

The essential function of the nervous system was primarily to secure some form of motor activity, first as a means of securing food, and later as a means of escaping from enemies and to promote procreation. Activities for the preservation of the individual and of the species were and are the only purposes for which the body energy is expended. The central nervous system has accordingly been developed for the purpose of securing such motor activities as will best adapt the individuals of a species for their self-preservative conflict with environment.

It is easy to appreciate that the simplest expressions of nerve response—the reflexes—are motor in character, but it is difficult to understand how such intangible reactions as love, hate, poetic fancy, or moral inhibition can be also the result of the adaptation to environment of a distinctively motor mechanism. We expect, however, to prove that so-called "psychic" states as well as the reflexes are products of adaptation; that they occur automatically in response to adequate stimuli in the environment; that like the reflexes they are expressions of motor activity, which, although intangible and unseen, in turn incites to activity the units of the motor mechanism of the body; and finally, that any "psychic" condition results in a definite depletion of the potential energy in the brain cells which is proportionate to

the muscular exertion of which it is the representative.

That this nerve mechanism may effectively carry out its twofold function, first, of self-adaptation to meet adequately the increasingly complicated stimuli of environment; and second, of in turn adapting the motor mechanism to respond adequately to its demands, there have been implanted in the body numerous nerve ceptors—some for the transmission of stimuli harmful to the mechanism—nociceptors; some of a beneficial character—beneceptors; and still others more highly specialized, which partake of the nature of both bene- and nociceptors—the distance ceptors, or special senses.

A convincing proof that environment has been the creator of man is seen in the absolute adaptation of the nociceptors as manifested in their specific response to adequate stimuli, and in their presence in those parts of the body only which throughout the history of the race have been most exposed to harmful contacts. We find they are most numerous in the face, the neck, the abdomen, the hands and the feet; while in the back they are few in number, and within the bony cavities they are lacking.

Instances of the specific responses made by the nociceptors might be multiplied indefinitely. Sneezing, for example, is a specific response made by the motor mechanism to stimulation of the nociceptors in the nose, while stimulation of the larynx does not produce a sneeze, but a cough; stimulation of the nociceptors of the stomach does not produce cough, but vomiting; stimulation of the nociceptors of the intestine does not produce vomiting, but increased peristaltic action. There are no nociceptors misplaced; none wasted; none that do not make an adequate response to adequate stimulation.

Another most significant proof that the environment of the past has been the creator of the man of to-day is seen in the fact that man has added to his environment certain factors to which adaptation has not as yet been made. For example, heat is a stimulus which has existed since the days of prehistoric man, while the X-ray is a discovery of to-day; to heat the nociceptors produce an adequate response; to the X-ray there is no response. There was no weapon in the prehistoric ages which could move at the speed of a bullet from the modern rifle; therefore, while slow penetration of the tissues produces great pain and muscular response, there is no response to the swiftly moving bullet.

The response to contact stimuli then depends always on the presence of nociceptors in the affected part of the body and to the type of the contact. Powerful response is made to crushing injury by environmental forces; to such injuring contacts as resemble the impacts of fighting; to such tearing injuries as resemble those made by teeth and claws. On the other hand, the sharp division of tissue by cutting produces no adaptive response; indeed, one might imagine that the body could be cut to pieces by a superlatively sharp knife applied at tremendous speed without material adaptive response.

These examples indicate how the history of the phylogenetic experiences of the human race may be learned by a study of the position and the action of the nociceptors just as truly as the study of the arrangement and variations in the strata of the earth's crust discloses to us geologic history.

These adaptive responses to stimuli are the result of the action of the brain cells which are thus continually played upon by the stimuli of environment. The energy stored in the brain cells in turn activates the various organs and parts of the body.

If the environmental impacts are repeated with such frequency that the brain cells have no time for restoration between them, the energy of the cells becomes exhausted and a condition of shock results. Every action of the body may thus be analyzed into a stimulation of ceptors, a consequent discharge of brain cell energy, and a final adaptive activation of the appropriate part. Walking, running and their modifications constitute an adaptation of wonderful perfection, for, as Sherrington has shown, the adaptation of locomotion consists of a series of reflexes—ceptors in the joints, in the limb and in the foot being stimulated by variations in pressure.

As we have shown, the bene- and nociceptors orientate man to all forms of physical contact—the former *guide him to* the acquisition of food and to sexual contact; the latter *direct him from* contacts of a harmful nature. The distance ceptors, on the other hand, adapt man to his distant environment by means of communication through unseen forces—ethereal vibrations produce sight; air waves produce sound; microscopical particles of matter produce smell. The advantage of the distance ceptors is that they allow time for orientation, and because of this great advantage the majority of man's actions are responses to their adequate stimuli. As Sherrington has stated, the greater part of the brain has been developed by means of stimuli received through the special senses, especially through the light ceptors, the optic nerves.

We have just stated that by means of the distance ceptors animals and man orientate themselves to their distant environment. As a result of the stimulation of the special senses chase and escape are effected, fight is conducted, food is secured, and mates are found. It is obvious, therefore, that the distance ceptors are the primary cause of continuous and exhausting expenditures of energy. On the other hand, stimuli applied to contact ceptors lead to short, quick discharges of nervous energy. The child puts his hand in the fire and there is an immediate and complete response to the injuring contact; he sees a pot of jam on the pantry shelf and a long train of continued activities are set in motion, leading to the acquisition of the desired object.

The contact ceptors do not at all promote the expenditure of energy in the chase or in fight, in the search for food or for mates. Since the distance ceptors control these activities, one would expect to find that they control also those organs whose function is the production of energizing internal secretions. Over these organs—the thyroid, the adrenals, the hypophysis—the contact ceptors have no control. Prolonged laboratory experimentation seems to prove this postulate. According to our observations, no amount of physical trauma inflicted upon animals will cause hyperthyroidism or increased epinephrin in the blood, while fear and rage do produce hyperthyroidism and increased epinephrin. This is a statement of far-reaching importance and is the key to an explanation of many chronic diseases—diseases which are associated with the intense stimulation of the distance ceptors in human relations.

Stimuli of the contact ceptors differ from stimuli of the distance ceptors in still another important particular. The adequacy of stimuli of the contact ceptors depends upon their number and intensity, while the adequacy of the stimuli of the distance ceptors depends upon the *experience* of the species and of the individual. That is, according to phylogeny and ontogeny this or that sound, this or that smell, this or that sight, through associa-

tion recapitulates the experience of the species and of the individual—awakens the phylogenetic and ontogenetic memory. In other words, sights, sounds and odors are symbols which awaken phylogenetic association. If a species has become adapted to make a specific response to a certain object, then that response will occur automatically in an individual of that species when he hears, sees or smells that object. Suppose for example, that the shadow of a hawk falls simultaneously on the eyes of a bird, a rabbit, a cow and a boy. That shadow would at once activate the rabbit and the bird to an endeavor to escape, each in a specific manner according to its phylogenetic adaptation; the cow would be indifferent and neutral; while the boy, according to his personal experience or ontogeny, might remain neutral, might watch the flight of the hawk with interest or might try to shoot it.

Each phylogenetic and each ontogenetic experience develops its own mechanism of adaptation in the brain; and the brain threshold is raised or lowered to stimuli by the strength and frequency of repetition of the experience. Thus through the innumerable symbols supplied by environment the distance ceptors drive this or that animal according to the type of brain pattern and the particular state of threshold which has been developed in that animal by its phylogenetic and ontogenetic experiences. The brain pattern depends upon his phylogeny, the state of threshold upon his ontogeny. Each *brain pattern* is created by some particular element in the environment to which an adaptation has been made for the good of the species. The *state of threshold* depends upon the effect made upon the individual by his personal contacts with that particular element in his environment. The presence of that element produces in the individual an associative recall of the adaptation of his species—that is, the brain pattern developed by his phylogeny becomes energized to make a specific response. The intensity of the response depends upon the state of threshold—that is, upon the associative recall of the individual's own experience—his ontogeny.

If the full history of the species and of the individual could be known in every detail, then every detail of that individual's conduct in health and disease could be predicted. Reaction to environment is the basis of conduct, of moral standards, of manners and conventions, of work and play, of love and hate, of protection and murder, of governing and being governed, in fact, of all the reactions between human beings—of the entire web of life. To quote Sherrington once more: "Environment drives the brain, the brain drives the various organs of the body."

By what means are these adaptations made; what is the mechanism through which adequate responses are made to the stimuli received by the ceptors? We postulate that in the brain there are innumerable patterns each the mechanism for the performance of a single kind of action, and that the brain cells supply the energy—electric or otherwise—by which the act is performed; that the energy stored in the brain cells is in some unknown manner released by the force which activates the brain pattern; and that through an unknown property of these brain patterns each stimulus causes such a change that the next stimulus of the same kind passes with greater facility.

Each separate motor action presumably has its own mechanism—brain pattern—which is activated by but one ceptor and by that ceptor only when physical force of a certain intensity and rate of motion is applied. This is true both of the visible

contacts affecting the nociceptors and of the invisible contacts by those intangible forces which affect the distance ceptors. For example, each variation in speed of the light-producing waves of ether causes a specific reaction in the brain. For one speed of ether waves the reaction is the perception of the color blue; for another, yellow; for another, violet. Changes in the speed of air waves meet with specific response in the brain patterns tuned to receive impressions through the aural nerves, and so we distinguish differences in sound pitch. If we can realize the infinite delicacy of the mechanisms adapted to these infinitesimal variations in the speed and intensity of invisible and intangible stimuli, it will not be difficult to conceive the variations of brain patterns which render possible the specific responses to the coarser contacts of visible environment.

Each brain pattern is adapted for but one type of motion, and so the specific stimuli of the innumerable ceptors play each upon their own brain patterns only. In addition, each brain pattern can react to stimuli applied only within certain limits. Too bright a light blinds; too loud a sound deafens. No mechanism is adapted for waves of light above or below a certain rate of speed, although this range varies in different individuals and in different species according to the training of the individual and the need of the species.

We have already referred to the fact that there is no receptive mechanism adapted to the stimuli from the X-ray, from the high-speed bullet, from electricity. So, too, there are innumerable forces in nature which can excite in man no adaptive response, since there exist in man no brain patterns tuned to their waves, as in the case of certain ethereal and radioactive forces.

On this mechanistic basis the emotions may be explained as activations of the entire motor mechanism for fighting, for escaping, for copulating. The sight of an enemy stimulates in the brain those patterns formed by the previous experiences of the individual with that enemy, and also the experiences of the race whenever an enemy had to be met and overcome. These many brain patterns in turn activate each that part of the body through which lies the path of its own adaptive response—those parts including the special energizing or activating organs. Laboratory experiments show that in an animal driven strongly by emotion the following changes may be seen: (1) a mobilization of the energy-giving compound in the brain cells, evidenced by a primary increase of the Nissl substance and a later disappearance of this substance and the deterioration of the cells; (2) increased output of epinephrin, of thyroid secretion, of glycogen and an increase of the power of oxidation in the muscles; (3) accelerated circulation and respiration with increased body temperature; (4) altered metabolism. All of these are adaptations to increase the motor efficiency of the mechanism. In addition we find an inhibition of the functions of every organ and tissue that consumes energy, but does not contribute directly to motor efficiency. The mouth becomes dry; the gastric and pancreatic secretions are lessened or are completely inhibited; peristaltic action stops. The obvious purpose of all these activations and inhibitions is to mass every atom of energy upon the muscles that are conducting the defense or attack.

So strong is the influence of phylogenetic experience that though an enemy today may not be met by actual physical attack, yet the decks are cleared for action, as it were, and the weapons made ready, the body as a result being shaken and ex-

hausted. The type of emotion is plainly declared by the activation of the muscles which would be used if the appropriate physical action were consummated. In anger the teeth are set, the fists are clenched, the posture is rigid; in fear the muscles collapse, the joints tremble and the running mechanism is activated for flight; in sexual excitement the mimicry is as obvious. The emotions, then, are the preparations for phylogenetic activities. If the activities are consummated, the fuel —glycogen—and the activating secretions from the thyroid, the adrenals, the hypophysis are consumed. In the activation without action, these products must be eliminated as waste products and so a heavy strain is put upon the organs of elimination. It is obvious that the body under emotion might be clarified by active muscular exercise, but the subject of the emotion is so strongly integrated thereby that it is difficult for him to engage in diverting, clarifying exertion. The person in anger does not want to be saved from the ill-effects of his own emotion; he wants only to fight; the person in fear wants only to escape; the person under sexual excitement wants only possession.

All the lesser emotions—worry, jealousy, envy, grief, disappointment, expectation—all these influence the body in this manner, the consequences depending upon the intensity of the emotion and its protraction. Chronic emotional stimulation, therefore, may fatigue or exhaust the brain and may cause cardiovascular disease, indigestion, Graves's disease, diabetes, and insanity even.

The effect of the emotions upon the body mechanism may be compared to that produced upon the mechanism of an automobile if its engines are kept running at full speed while the machine is stationary. The whole machine will be shaken and weakened, the batteries and weakest parts being the first to become impaired and destroyed, the length of usefulness of the automobile being correspondingly limited.

We have shown that the effects upon the bodily mechanism of the action of the various ceptors is in relation to the response made by the *brain* to the stimuli received. What is this power of response on the part of the brain but *consciousness?* If this is so, then consciousness itself is a reaction to environment, and its intensity must vary with the state of the brain and with the environmental stimuli. If the brain cells are in the state of highest efficiency, if their energy has not been drawn upon, then consciousness is at its height; if the brain is fatigued, that is, if the energy stored in the cells has been exhausted to any degree, then the intensity of consciousness is diminished. So degrees of consciousness vary from the height maintained by cells in full vigor through the stages of fatigue to sleep, to the deeper unconsciousness secured by the administration of inhalation anesthetics, to that complete unconsciousness of the environment which is secured by blocking the advent to the brain of all impressions from both distance and contact ceptors, by the use of both local and inhalation anesthetics —the state of anoci-association.

Animals and man may be so exhausted as to be only semi-conscious. While a brain perfectly refreshed by a long sleep can not immediately sleep again, the exhausted brain and the refreshed brain when subjected to equal stimuli will rise to unequal heights of consciousness. The nature of the physical basis of consciousness has been sought in experiments on rabbits which were kept awake from 100 to 109 hours. At the end of this time they were in a state of extreme exhaustion and seemed semiconscious. If the wakefulness had been further prolonged, this state of semi-con-

sciousness would have steadily changed until it culminated in the permanent unconsciousness of death. An examination of the brain cells of these animals showed physical changes identical with those produced by exhaustion from other causes, such as prolonged physical exertion or emotional strain. After 100 hours of wakefulness the rabbits were allowed a long period of sleep. All the brain cells were restored except those that had been in a state of complete exhaustion. A single seance of sleep served to restore some of the cells, but those which had undergone extreme changes required very prolonged rest. These experiments give us a definite physical basis for explaining the cost to the body mechanism of maintaining the conscious state. We have stated that the brain cell changes produced by prolonged consciousness are identical with those produced by physical exertion and by emotional strain. Rest, then, and especially sleep, is needed to restore the physical state of the brain cells which have been impaired, and as the brain cells constitute the central battery of the body mechanism, their restoration is essential for the maintenance of normal vitality.

In ordinary parlance, by consciousness we mean the activity of that part of the brain in which associative memory resides, but while associative memory is suspended the activities of the brain as a whole are by no means suspended; the respiratory and circulatory centers are active, as are those centers which maintain muscular tone. This is shown by the muscular response to external stimuli made by the normal person in sleep; by the occasional activation of motor patterns which may break through into consciousness causing dreams; and finally by the responses of the motor mechanism made to the injuring stimuli of an operation on a patient under inhalation anesthesia only.

Direct proof of the mechanistic action of many of life's phenomena is lacking, but the proof is definite and final of the part that the brain cells play in maintaining consciousness; of the fact that the degree of consciousness and mental efficiency depends upon the physical state of the brain cells; and finally that efficiency may be restored by sleep, provided that exhaustion of the cells has not progressed too far. In this greatest phenomenon of life, then, the mechanistic theory is in harmony with the facts.

Perhaps no more convincing proof of our thesis that the body is a mechanism developed and adapted to its purposes by environment can be secured than by a study of that most constant manifestation of consciousness—pain.

Like the other phenomena of life, pain was undoubtedly evolved for a particular purpose—surely for the good of the individual. Like fear and worry, it frequently is injurious. What then may be its purpose?

We postulate that pain is a result of contact ceptor stimulation for the purpose of securing protective muscular activity. This postulate applies to all kinds of pain, whatever their cause—whether physical injury, pyogenic infection, the obstruction of hollow viscera, childbirth, etc.

All forms of pain are associated with muscular action, and as in every other stimulation of the ceptors, each kind of pain is specific to the causative stimuli. The child puts his hand in the fire; physical injury pain results and the appropriate muscular response is elicited. If pressure is prolonged on some parts of the body, anemia of the parts may result, with a corresponding discomfort or pain, requiring muscular action for relief. When the rays

of the sun strike directly upon the retina, light pain causes an immediate protective action; so too in the evacuation of the intestine and the urinary bladder as normal acts, and in overcoming obstruction of these tracts, discomfort or pain compel the required muscular actions. This view of pain as a stimulation to motor action explains why only certain types of infection are associated with pain; namely, those types in which the infection may be spread by muscular action or those in which the fixation of parts by continued muscular rigidity is an advantage. As a further remarkable proof of the marvelous adaptation of the body mechanism to meet varying environmental conditions, we find that just as nociceptors have been implanted in those parts of the body only which have been subject to nocuous contacts, so a type of infection which causes muscular action in one part of the body may cause none when it attacks another.

This postulate gives us the key to the pain-muscular phenomena of peritonitis, pleurisy, cystitis, cholecystitis, etc., as well as to the pain-muscular phenomena in obstructions of the hollow viscera. If pain is a part of a muscular response and occurs only as a result of contact ceptor stimulation by physical injury, infection, anemia, or obstruction, we may well inquire which part of the nerve mechanism is the site of the phenomenon of pain. Is it the nerve ending, the nerve trunk, or the brain? That is, is pain associated with the physical contact with the nerve ending, or with the physical act of transmission along the nerve trunk, or with the change of brain cell substance by means of which the motor-producing energy is released?

We postulate that the pain is associated with the discharge of energy from the brain cells. If this is true, then if every nociceptor in the body were equally stimulated in such a manner that all the stimuli should reach the brain cells simultaneously, then the cells would find themselves in equilibrium and no motor act would be performed. But if all the pain nerve ceptors but one were equally stimulated, and this one more strongly stimulated than the rest, then this one would gain possession of the final common path—would cause a muscular action and the sensation of pain.

It is well known that when a greater pain or stimulus is thrown into competition with a lesser one, the lesser is submerged. Of this fact the schoolboy makes use when he initiates the novice into the mystery of the painless pulling of hair. The simultaneous but severe application of the boot to the blindfolded victim takes complete but exclusive possession of the final common path and the hair is painlessly plucked as a result of the triumph of the boot stimulus over the pull on the hair in the struggle for the final common path.

Persons who have survived a sudden, complete exposure to superheated steam, or whose bodies have been enwrapped in flame, testify that they have felt no pain. As this absence of pain may be due to the fact that the emotion of fear gained the final common path, to the exclusion of all other stimuli, we are trying by experimentation to discover the effects of simultaneous painful stimulation of all parts of the body. The data already in hand, and the experiments now in progress, in which anesthetized animals are subjected to powerful stimuli applied to certain parts of the body only, or simultaneously to all parts of the body, lead us to believe that in the former case the brain cells become stimulated or hyperchromatic, while in the latter case no brain cell changes occur. We believe that our experiments will prove that an equal and simultaneous stimula-

tion of all parts of the body leaves the brain cells in a state of equilibrium. Our theory of pain will then be well sustained, not only by common observation, but by experimental proof, and so the mechanistic view will be found in complete harmony with another important reaction.

We have stated that when a number of contact stimuli act simultaneously, the strongest stimulus will gain possession of the final common path—the path of action. When, however, stimuli of the distance ceptors compete with stimuli of the contact ceptors, the contact-ceptor stimuli often secure the common path, not because they are stronger or more important, but because they are immediate and urgent. In many instances, however, the distance-ceptor stimuli are strong, have the advantage of a lowered threshold, and therefore compete successfully with the immediate and present stimuli of the contact ceptors. In such cases we have the interesting phenomenon of physical injury without resultant pain or muscular response. The distance ceptor stimuli which may thus triumph over even powerful contact-ceptor stimuli are those causing strong emotions —as great anger in fighting; great fear in a battle; intense sexual excitement. Dr. Livingstone has testified to his complete unconsciousness to pain during his struggle with a lion; although he was torn by teeth and claws, his fear overcame all other impressions. By frequently repeated stimulation the Dervish secures a low threshold to the emotions caused by the thought of God or the devil and his emotional excitement is increased by the presence of others under the same stimulation; emotion, therefore, secures the final common path and he is unconscious of pain when he lashes, cuts and bruises his body. The phenomena of hysteria may be explained on this basis, as may the unconsciousness of passing events in a person in the midst of a great and overwhelming grief. By constant practise the student may secure the final common path for such impressions as are derived from the stimuli offered by the subject of his study, and so he will be oblivious of his surroundings. Concentration is but another name for a final common path secured by the repetition and summation of certain stimuli.

If our premises are sustained then we can recognize in man no will, no ego, no possibility for spontaneous action, for every action must be a response to the stimuli of contact or distance ceptors, or to their recall through associative memory. Memory is awakened by symbols which represent any of the objects or forces associated with the act recalled. Spoken and written words, pictures, sounds, may stimulate the brain patterns formed by previous stimulation of the distance ceptors; while touch, pain, temperature, pressure, may recall previous contact-ceptor stimuli. Memory depends in part upon the adequacy of the symbol, and in part upon the state of the threshold. If one has ever been attacked by a snake, the threshold to any symbol which could recall that attack would be low; the later recall of anything associated with the bite or its results would produce in memory a recapitulation of the whole scene, while even harmless snakes would thereafter be greeted with a shudder. On the other hand, in a child the threshold is low to the desire for the possession of any new and strange object; in a child, therefore, to whom a snake is merely an unusual and fascinating object, there is aroused only curiosity and the desire for the possession of a new plaything.

If we are to attribute to man the possession of a governing attribute, not possessed by other parts of the animal creation,

where are we to draw the boundary line, and say " here the ego—the will—the reason—emerges "? What attribute, after all, has man which in its ultimate analysis is not possessed by the lowest animals or by the vegetable creation, even? From the amœba, on through all the stages of animal existence, every action is but a response to adequate stimulus; and as a result of adequate stimuli each step has been taken toward the higher and more intricate mechanisms which play the higher and more intricate parts in the great scheme of nature.

The Venus fly trap responds to as delicate a stimulus as do any of the contact ceptors of animals, and the motor activity resulting from the stimulus is as complex. To an insect-like touch the plant responds; to a rough contact there is no response; that is, the motor mechanism of the plant has become attuned to only such stimuli as simulate the contact of those insects which form its diet. It catches flies, eats and digests them, and ejects the refuse. The amœba does no less. The frog does no more, excepting that in its place in creation a few more reactions are required for its sustenance and for the propagation of its species. Man does no more, excepting that in man's manifold relations there are innumerable stimuli, for meeting which adequately, innumerable mechanisms have been evolved. The motor mechanism of the fly trap is perfectly adapted to its purpose. The motor mechanism of man is adapted to its manifold uses, and as new environmental influences surround him, we must believe that new adaptations of the mechanism will be evolved to meet the new conditions.

Is not this conception of man's activities infinitely more wonderful, and infinitely more comprehensible than is the conception that his activities may be accounted for by the existence of an unknown, unimaginable, and intangible force called " mind " or " soul "?

We have already shown how the nerve mechanism is so well adapted to the innumerable stimuli of environment that it can accurately transmit and distinguish between the infinite variations of speed in the ether waves producing light, and the air waves producing sound. Each rate of vibration energizes only the mechanism which has been attuned to it. With marvelous accuracy the light and sound waves gain access to the nerve tissue and are finally interpreted in terms of motor responses, each by the brain pattern attuned to that particular speed and intensity. So stimuli and resultant actions multiplied by the total number of the motor patterns in the brain of man give us the sum total of his life's activities—they constitute his life.

As in evolutionary history the permanence of an adaptation of the body mechanism depends upon its value in the preservation of the life of the individual and upon its power to increase the value of the individual to the race, so the importance and truth of these postulates and theories may well be judged on the same basis.

The fundamental instincts of all living matter are self-preservation, and the propagation of the species. The instinct for self-preservation causes a plant to turn away from cold and damaging winds toward the life-giving sun; the inert mussel to withdraw within its shell; the insect to take flight: the animal to fight or to flee; and man to procure food that he may oppose starvation, to shelter himself and to provide clothes that he may avoid the dangers of excessive cold and heat, to combat death from disease by seeking medical aid, to avoid destruction by man or brute by fight or by flight. The instinct to propagate the species leads brute man by crude

methods, and cultured man by methods more refined, to put out of his way sex rivals so that his own life may be continued through offspring. The life of the species is further assured by the protective action exercised over the young by the adults of the species. As soon as the youngest offspring is able successfully to carry on his own struggle with environment there is no longer need for the parent, and the parent enters therefore the stage of disintegration. The average length of life in any species is the sum of the years of immaturity, plus the years of female fertility, plus the adolescent years of the offspring.

The stimuli resulting from these two dominant instincts are now so overpowering as compared with all other environmental stimuli that the mere possession of adequate knowledge of the damaging effects of certain actions as compared with the saving effects of others will (other things being equal) lead the individual to choose the right,—the self- and species-preservative course of action, instead of the wrong,—the self- and species-destructive course of action.

The dissemination of the knowledge of the far-reaching deleterious effects of protracted emotional strain, of overwork, and of worry will automatically raise man's threshold to the damaging activating stimuli causing the strong emotions, and will cause him to avoid dangerous strains of every kind. The individual thus protected will therefore rise to a plane of poise and efficiency far above that of his uncontrolled fellows, and by so much will his efficiency, health and happiness be augmented.

A full acceptance of this theory can not fail to produce in those in whose charge rests the welfare of the young, an overwhelming desire to surround children with those environmental stimuli only which will tend to their highest ultimate welfare.

Such is the stimulating force of tradition that many who have been educated under the tenets of traditional beliefs will oppose these hypotheses—even violently, it may be. So they have opposed them; so they opposed Darwin; so they have opposed all new and apparently revolutionary doctrines. Yet these persons themselves are by their very actions proving the efficiency of the vital principles which we have enunciated. What is the whole social welfare movement but a recognition on the part of municipalities, educational boards, and religious organizations of the fact that the future welfare of the race depends upon the administration to the young of forceful uplifting environmental stimuli.

There are now, as there were in Darwin's day, many who feel that man is degraded from his high estate by the conception that he is not a reasoning, willing being, the result of a special creation. But one may wonder indeed what conception of the origin of man can be more wonderful or more inspiring than the belief that he has been slowly evolved through the ages, and that all creatures have had a part in his development; that each form of life has contributed and is contributing still to his present welfare and to his future advancement.

RECAPITULATION

Psychology—the science of the human soul and its relations—under the mechanistic theory of life, must receive a new definition. It becomes a science of man's activities as determined by the environmental stimuli of his phylogeny and of his ontogeny.

On this basis we postulate that throughout the history of the race nothing has been lost, but that every experience of the race and of the individual has been retained for the guidance of the individual and of the race; that for the accomplishment of this

end, there has been evolved through the ages a nerve mechanism of such infinite delicacy and precision that in some unknown manner it can register permanently within itself every impression received in the phylogenetic and ontogenetic experience of the individual; that each of these nerve mechanisms or brain patterns has its own connection with the external world, and that each is attuned to receive impressions of but one kind, as in the apparatus of wireless telegraphy each instrument can receive and interpret waves of a certain rate of intensity only; that thought, will, ego, personality, perception, imagination, reason, emotion, choice, memory, are to be interpreted in terms of these brain patterns; that these so-called phenomena of human life depend upon the stimuli which can secure the final common path, this in turn having been determined by the frequency and the strength of the environmental stimuli of the past and of the present.

Finally, as for life's origin and life's ultimate end, we are content to say that they are unknown, perhaps unknowable. We know only that living matter, like lifeless matter, has its own place in the cosmic processes; that the gigantic forces which operated to produce a world upon which life could exist, as a logical sequence, when the time was ripe, evolved life; and finally that these cosmic forces are still active, though none can tell what worlds and what races may be the result of their coming activities.

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THE CHESTNUT-BLIGHT PARASITE (ENDOTHIA PARASITICA) FROM CHINA

IN common with Dr. Metcalf[1] and some other pathologists the writers have believed in the foreign origin of the chestnut-blight and its causal organism.

Having first proved by thorough investigation[2] that the species of *Endothia* (*E. radicalis* (Schw.) De Not.) common on the chestnut in southern Europe is not an active parasite and is morphologically distinct from *E. parasitica* our attention was again turned to the orient. Previous efforts to get *Endothia* by correspondence from China and Japan have been fruitless.

Knowing Mr. Meyer's keenness of observation and facilities for examining chestnuts in China, it occurred to us to try to enlist his services in the search for the fungus. We took up the matter with Mr. Fairchild early in February, 1913. He heartily approved of the proposition and data were prepared and sent to Mr. Meyer. On June 28, as Mr. Fairchild has related, a letter was received from Mr. Meyer enclosing a small specimen of diseased chestnut bark collected June 3, 1913, near San tun ying, Chili Province, China. This specimen showed the characteristic mycelial "fans" in the bark and a few pycnidia which agreed exactly in macroscopic and microscopic characters with *Endothia parasitica*. Meyer's description of the disease on these Chinese chestnut trees (whose specific determination is still under investigation) also agreed with the behavior of the disease on some oriental chestnut trees in this country.

Cultures on cornmeal were made June 30 from the mycelium and from pycnospores from Meyer's specimen. The cultures from mycelium did not grow, but three of the four cultures made from pycnospores developed normally and appeared pure. Cultures of *Endothia parasitica* from American material were also made at the same time on the same medium for comparison. The development of the Chinese fungus was in all cases indistinguishable from that of American origin. The amount of growth, the color and character of the mycelium, time of appearance, abundance and distribution of pycnidia were so similar that it was impossible to tell the cultures

[1] Bur. Plant Ind., U. S. Dept. Agr., Bull. 121, pt. 6, 1908; also *Trans. Mass. Hort. Soc.*, 1912, pt. 1, pp. 69–95.

[2] C. L. Shear, "*Endothia radicalis* (Schw.)," *Phytopathology*, 3: 61, February, 1913.

apart. Twelve subcultures made from the original flasks also behaved exactly like *E. parasitica.* Fifteen pycnospore streak cultures on potato agar from the Chinese material and the same number from American material were made July 10. The development in all these cultures was the same, giving the characteristic growth and colors of the parasite as recently described by the writers.[3] The only difference noted was that the distinctive orange color of the mycelium at the base of the cornmeal agar slants began to show one day earlier in some of the Chinese than in the American cultures. Cultures of the parasite of both Chinese and American origin were also made on sterile chestnut twigs and on upright tubes of cornmeal agar and oatmeal in flasks. In all cases the organism behaved in exactly the same manner and gave a typical growth of the chestnut-blight fungus.

July 7 fourteen inoculations of several sprouts of *Castanea dentata,* eight to ten centimeters in diameter, were made in the vicinity of Washington with mycelium from one of the original cultures from the Chinese specimen. Within one week all inoculations showed evidence of disease. At the end of nine days the sunken areas of bark about the points of inoculation extended in some cases 1 to 1.5 cm. Microscopic examination showed well-marked typical mycelial "fans" in the bark. At the end of two weeks all of the 14 inoculations were rapidly developing and showed diseased areas of sunken bark often extending 2 to 3 cm. from the line of inoculation. Many pycnidia were present, but no spore threads or horns had appeared. The characteristic mycelial "fans" were conspicuous in the bark. None of the five checks showed any signs of disease. At the last examination of the inoculations made August 11 all were developing rapidly. The largest canker was 6 cm. wide and 14 cm. long. Pycnidia of *Endothia parasitica* with extruding spore masses were abundant. Pycnospores from these cankers appear identical in shape and general appearance with those from the original Chinese specimen and also with those from American specimens. The measurements of the pycnospores are as follows:

From an American specimen:

Maximum length	6.15 microns.
Minimum length	3.42 microns.
Average length	4.69 microns.
Maximum width	2.3 microns.
Minimum width	1.84 microns.
Average width	2.09 microns.

From Meyer's Chinese specimen:

Maximum length	5.84 microns.
Minimum length	3.3 microns.
Average length	4.75 microns.
Maximum width	2.38 microns.
Minimum width	1.84 microns.
Average width	2.05 microns.

Specimens from inoculations with the Chinese fungus:

Maximum length	6.3 microns.
Minimum length	3.46 microns.
Average length	4.67 microns.
Maximum width	2.3 microns.
Minimum width	1.76 microns.
Average width	2.04 microns.

Meyer's first specimen showed no perithecia. On July 23 more Chinese specimens were received from the same locality. These included a large typical canker on a chestnut branch about 6 cm. in diameter which agreed in every respect with cankers produced on varieties of Japanese chestnuts in this country. Other specimens in this collection showed well-developed perithecia and ascospores. Measurements of 100 ascospores from the Chinese specimen gave a

Maximum length of	11.1 microns.
Minimum length of	6.9 microns.
Average length of	8.4 microns.
Maximum width of	5.3 microns.
Minimum width of	3.5 microns.
Average width of	4.39 microns.

The same number of measurements from a typical American specimen gave a

Maximum length of	10.8 microns.
Minimum length of	6.9 microns.
Average length of	8.49 microns.
Maximum width of	5.1 microns.
Minimum width of	3.6 microns.
Average width of	4.32 microns.

[3] "'Cultural Characters of the Chestnut-Blight Fungus and its near Relatives,'' Circ. No. 131, B. P. I., Dept. Agr., July 5, 1913.

The uniformity and constancy of both the physiological and morphological characters of this fungus are quite remarkable and striking.

The Chinese organism has thus been shown to be practically identical with the American in all its morphological and physiological characters and in the production of the typical chestnut-blight and the pycnidial fructifications of the fungus. There is apparently but one other requirement that could be made according to the strictest pathological canons to perfect the proof in this case, and that is the production of typical ascospores of *E. parasitica* on the lesions produced by the inoculations. These could scarcely be expected to appear for some weeks yet. The evidence, however, appears to us sufficiently complete to allow no escape from the conclusion that *Endothia parasitica* occurs in China and in such a locality and under such conditions as would indicate that it is indigenous there.

Just as this note was finished, Mr. Fairchild received a package of photographs of blighted chestnut trees from Mr. Meyer, taken in the same locality from which the specimens were obtained. These will be published later. Suffice it to add here that the illustrations show clearly by the evident age of the trees and of the infections that this Chinese chestnut is much more resistant to the disease than the American and that there is much hope for the successful selection and breeding of resistant plants.

C. L. SHEAR
NEIL E. STEVENS

BUREAU OF PLANT INDUSTRY,
August 16, 1913

THE DISCOVERY OF THE CHESTNUT BARK DISEASE IN CHINA

MR. FRANK N. MEYER, agricultural explorer of the Office of Foreign Seed and Plant Introduction of the Department of Agriculture, during his first exploring trip in northern China, 1905–1908, visited the Pang shan region east of Peking. He reported upon the existence of considerable quantities of wild chestnuts there, where they "grow wild on the slopes of rocky mountains. . . . It is mostly found in groves, growing among rocks and bowlders, and even in its wild state it varies considerably in the size and flavor of its nuts and the spininess of the burrs. The Chinese name for the wild form is San li tze,"[1] otherwise spelled Shan-li-tze. At the time of Mr. Meyer's exploration in the Pang shan region, there was comparatively little interest in this country in the chestnut bark disease, and not being a plant pathologist, he did not look for the disease among the chestnut trees from which he gathered chestnuts for introduction into this country.

When it was announced that Mr. Meyer would make a second expedition to north China, the question was raised by Drs. Metcalf and Shear, of the Office of Forest Pathology, as to whether or not Meyer might be requested to search for the disease among these Chinese chestnuts. On February 26, 1913, therefore, at Dr. Shear's request, Mr. Meyer was asked to make a search for the disease, and in order to inform him specifically as to what to look for, specimens of the diseased bark were sent him.

On June 13, 1913, the American legation cabled the state department as follows: "Meyer requests the legation to report that he has discovered chestnut bark fungus. Seems identical with American form."

On June 28 a letter was received from Mr. Meyer, written June 4 from a Chinese inn in an old dilapidated town to the northeast of Peking, between Tsun hua tcho and Yehol. In it Mr. Meyer announces the sending of a small fragment of diseased chestnut bark.[2]

[1] Meyer, Frank N., "Agricultural Explorations in the Fruit and Nut Orchards of China," Bulletin No. 204, Bureau of Plant Industry, p. 52, March 25, 1911.

[2] SAN TUN YING, CHILI PROV., CHINA,
MR. DAVID FAIRCHILD, June 4, 1913.
Agricultural Explorer in Charge,
U. S. Department of Agriculture,
Washington, D. C., U. S. A.

Dear Mr. Fairchild: Here I am sitting in a Chinese inn in an old dilapidated town to the northeast of Peking, between *Tsun hua tcho* and

A subsequent shipment of the diseased material, consisting of bark and diseased branches of the tree, a few mature burrs, and nuts, was received July 28, 1913, and on August 11 a number of convincing photographs of the diseased chestnut tree. Full botanical material for identification of this particular species which Mr. Meyer has been asked to get has not yet arrived, and the burrs do not agree with the description of *Castanea mollissima* Blume. This species according to the identification of the Arnold Arboretum authorities was collected by Mr. Meyer in the Pang shan region in 1907, and is now growing in this country under our S. P. I. number 21875. The region where Mr. Meyer discovered the disease is very close to the locality in the Pang shan region where he collected the nuts of *Castanea mollissima* in 1907, but it is impossible at this writing to determine with certainty the identity of this partially resistant Chinese species from San tun ying. This whole question will be discussed in a subsequent paper.

Those better qualified, Messrs. Shear and Stevens, are describing in this same number of SCIENCE the various steps taken by them in corroborating Meyer's discovery of the presence of the disease in China. It is interesting

Yehol and have been busy for several days collecting specimens of this bad chestnut bark disease and taking photos of same. It seems that this Chinese fungus is apparently the same as the one that kills off the chestnut trees in northeast America. I hope to send a cablegram through the American legation at Peking about this discovery to the Secretary of Agriculture. I am also enclosing a small piece of bark with this fungus on it. More material I hope to send off from Tientsin and Peking. Here are my main observations:

This blight does not by far do as much damage to Chinese chestnut trees as to the American ones.

Not a single tree could be found which had been killed entirely by this disease, although there might have been such trees which had been removed by the ever active and economic Chinese farmers.

Dead limbs, however, were often seen and many a saw wound showed where limbs had been removed.

Young trees and trees on level, poor soil were much more severely attacked than old trees or trees growing on richer, sloping soil at the base of rocks and hills. . . . The wounds on the bigger majority of the trees were in the process of healing over.

The Chinese farmers ascribe this disease to the working of caterpillars, grubs and ants, which are very freely found beneath the bark on these diseased spots on the main trunks and branches.

To combat the disease they scrape the bark clean every winter or early spring. The strips of bark are all collected, tied up in bundles and sold as fuel.

This Chinese chestnut does not grow to such sizes as the American one. Trees over 40 feet are rare. They are of low-branching habits with open heads, more or less in the way of the European chestnut (*Castanea vesca*).

The lumber is hard, but even a good-sized tree produces relatively little good lumber.

Old wounds are to be observed here and there on ancient trees.

The maximum age of this Chinese chestnut as seen in its native habitat seems to be between 250 and 300 years, but when that old they are already in decay.

The tree is not a fast grower and does not begin to bear until 12 to 15 years old.

The soil best suited to these chestnuts is a warm, well decomposed granite, with perfect drainage, while as locality they love the lower slopes of hills and mountains, where they are well sheltered.

The valleys and ravines in the lower altitudes of the Rocky Mountain regions would probably supply congenial localities for these chestnuts.

This northern Chinese chestnut is not a lumber tree, but attempts might be made to cross it with the American species, trying to give the last one more hardiness and resistancy against disease.

The nuts of this Chinese chestnut are not as large as those from the European and Japanese forms, but they are very sweet and are in great demand in China.

The great chestnut district of north China lies in the mountain valleys between the town of San tun ying and the Great Chinese Wall, 4 to 5 days' journey by carts from Peking to the northeast or 1½ to 2 days' journey by carts from the railroad station Tang shan on the railroad from Tientsin to Shan hai kwan. Most of the trees seen seem to be original growth, but also plantations have been made at the foot of the mountains and hills. . . .

to note, however, that only forty-two days elapsed from the time Meyer cabled, June 13, until every link in the chain of evidence of the identity of the Chinese with the American disease was complete. This included the discovery of the characteristic "mycelial fans," the making of cultures which appeared identical, the producing of the disease in American chestnut trees by inoculation from the cultures, and the discovery on July 24 of the ascospores of the fungus, *Endothia parasitica* (Murr.), on material later sent in. When we consider that the little town in the Chili province of China is a day and a half cart journey from a railroad, it is interesting to note the promptness with which exact laboratory research methods in Washington can be brought to bear on a field problem half way round the globe.

David Fairchild

U. S. Department of Agriculture

SCIENTIFIC NOTES AND NEWS

The committee of the permanent commission for the International Congress of Medicine to be held in Munich in 1917 has been elected as follows: President, Professor Dr. Friedrich von Müller, of Munich (president-elect for the eighteenth congress); vice-presidents, M. Calman Müller, of Budapest (president of the sixteenth congress), and Sir Thomas Barlow, of London (president of the seventeenth congress); secretary-general, M. H. Burger, of Amsterdam; assistant secretary, D. Ph. van der Haer, of The Hague; member, M. L. Dejace, of Liège (president of the International Association of the Medical Press).

Dr. Roux, director of the Pasteur Institute, has been appointed a grand officer of the Legion of Honor.

Mr. Robert Bridges, newly appointed poet laureate in Great Britain, holds a degree in medicine from Oxford and for some years was a practising physician.

The Paris Academy of Sciences has awarded its Valz prize to Professor A. Fowler, F.R.S., for his investigations on the spectrum of hydrogen and other contributions to astrophysics.

Drs. A. Bacmeister and L. Küpferle, of Freiburg, have received $1,000 from the Robert Koch foundation for their studies on Röntgen therapy in tuberculosis.

Dr. C. F. Hodge, professor of biology at Clark University, will have leave of absence next year and will conduct work in Oregon under the extension department of the university and the Oregon state game commission.

Dr. Henry Fairfield Osborn, president of the American Museum of Natural History, has been visiting the expeditions conducting paleontological explorations for the museum in the west.

Dr. F. Robert Helmert, the distinguished Berlin geodesist, celebrated his seventieth birthday on July 21.

Professor Archibald Barr is about to retire from the regius chair of civil engineering and mechanics at the University of Glasgow.

The Michigan State Board of Health has offered the position of state sanitary engineer to Professor E. D. Rich, of the University of Michigan.

Mr. James A. Barr, who for the past year has been manager of the Bureau of Conventions and Societies of the Panama-Pacific International Exposition, has been appointed chief of the department of education. He will have general charge of the congresses and conventions as well as of the educational exhibits. Dr. Irwin Shepard, for twenty years secretary of the National Education Association, has been appointed national secretary of the Bureau of Conventions, in San Francisco. Up to this time 151 congresses and conventions have been scheduled for San Francisco or near-by cities in 1915. At the meeting of the National Education Association held in Salt Lake City in July, the directors recommended that the 1915 meeting be held in Oakland, just across the Bay from San Francisco and within an hour of the Exposition grounds. The directors also recommended that an International Congress on Education be held in Oakland in 1915, under the general direction of a commission of thirty-four educators, with

Commissioner P. P. Claxton as ex-officio chairman and Mr. D. W. Springer as ex-officio secretary.

The fourteenth course of Lane Medical Lectures will be delivered in Lane Hall, San Francisco, on the evenings of September 3, 4, 5, 8 and 9, by Professor Sir Edward Schäfer, professor of physiology, University of Edinburgh. The subjects are as follows:

September 3—On internal secretion in general.
September 4—On the thyro-parathyroid glands.
September 5—On the adrenal glandular apparatus.
September 8—On the pituitary body.
September 9—The influence of internal on other secretions.
Methods of Resuscitation. (To be delivered at Stanford University.)

Among the lectures at the University of Chicago were those by Professor Carl Schröter, of the University of Zurich, who gave on August 6 and 7 two illustrated lectures on "The Lake Dwellings and Lake Dwellers of Ancient Switzerland" and "The Alpine Flora of Switzerland." On August 20 Professor Stephen A. Forbes, of the University of Illinois, gave an illustrated lecture in Kent Theater on "Fish and Their Ecological Relations," and Professor William Morton Wheeler, of Harvard University, discussed in two lectures this week "The Habits of Ants."

Professor Mel T. Cook, of the New Jersey Agricultural Station, while a visitor at the Biological Laboratory, recently gave a lecture on insect galls.

The town of Sanseverino in Italy will hold a celebration in September in honor of the quadricentenary of Bartolomeo Eustachio, the anatomist. A marble tablet will be unveiled and there will be a medical congress.

Mr. C. Leslie Reynolds, superintendent of the National Botanical Gardens in Washington, with which he had been connected for forty years, has died at the age of fifty-five years.

Mr. Frederick G. Plummer, geographer of the United States Forest Service, died on August 18, aged sixty-nine years.

The death is announced of Mr. T. H. Russell, of Birmingham, the author of a work on mosses and liverworts.

Dr. Hermann Credner, professor of geology at Leipzig and director of the Saxony Geological Survey, has died at the age of seventy-two years.

Dr. von Vogel, who had performed an important service in the organization of the Bavarian military health service, has died at the age of seventy-nine years.

The U. S. Civil Service Commission announces an examination for entomological assistant in the Bureau of Entomology, Department of Agriculture, for service in the field, at $2,250. The duties of this position will be to conduct a special investigation of the means of control of malaria-transmitting mosquitoes. It is desired to secure the services of a person who is familiar with the methods of control and eradication of mosquitoes in tropical and subtropical countries. Familiarity with the appearance and details of chronic malaria will also be of value. Other civil service examinations are: for assistant in botanical laboratory work in the Bureau of Plant Industry, at a salary of $1,500; for electrometallurgist in the Bureau of Mines at a salary ranging from $1,800 to $3,000; and for publicity expert in the Office of Public Roads, at a salary of $8 per day when employed.

The International Geological Congress will hold its next meeting in Brussels in 1917.

The International Solar Union, at its meeting at Bonn on August 5, passed the following resolution:

That, in collecting material for a report, the chairman of a committee may employ the method proposed in Science, Vol. 37, page 795.

It will be remembered that Dr. E. C. Pickering, director of the Harvard College Observatory, there suggested a standard form of committee meetings by correspondence.

For the first time in the history of the British Association psychology will be represented as an independent subject at the

forthcoming Birmingham meeting. It appears as a subsection to Section I (Physiology), and among those who have agreed to present papers are: Professor R. M. Ogden on "Experimental Data on the Localization of Visual Images"; Mr. C. Fox, "The Conditions which arouse Mental Imagery in Thought"; Professor Dawes Hicks, "Is there a Process of Psychical Fusion"; Dr. W. G. Smith, "Contrast as a Factor in Psychological Explanation"; Dr. C. S. Myers, "Experiments on Sound Localization"; Professor C. Read, "The Conditions of Belief in Primitive Minds"; Mr. W. McDougall, "A Theory of Laughter"; Dr. Wildon Carr, "The Absurdity of Psycho-physical Parallelism"; Miss May Smith, "Two Forms of Memory and their Relation"; Miss E. M. Smith, "Note of Habit Formation in Guinea-pigs"; Dr. F. C. Shrubsall, "The Relative Fertility and Morbidity of Normal and Defective Stock"; Mr. J. H. Wimms, "A Comparative Investigation of Fatigue Tests"; Miss May Smith, "Some Experiments on Recovery from Fatigue"; Dr. G. Thomson, "Variations in the Spatial Threshold"; Mr. Shepherd Dawson, "A Simple Method of Demonstrating Weber's Law"; Miss S. S. Fairhurst, "Suggestion and Discipline in Spelling"; Dr. C. W. Valentine, "Color Perception and Preference of an Infant"; Dr. McIntyre, "Practise Improvement in Immediate Memory in School Children"; Dr. E. O. Lewis, "Analytic and Synthetic Processes in Learning"; Dr. McIntyre and Miss A. L. Rogers, "Application of the Binet Scale to Normal Children in Scotland"; Mr. R. C. Moore, "Tests of Reasoning and their Relation to Mental Ability"; Mr. W. H. Winch, "Some Additional Tests of Reasoning"; Mr. T. H. Pear, "Modern Experiments on Testimony"; Mr. S. Wyatt, "The Testimony of Normal and Defective Children"; Dr. W. Brown, "Psycho-analysis"; Mr. T. H. Pear, "The Analysis of Some Personal Dreams with Special Reference to Theories of Dream Interpretation", and Mr. C. Burt, "Mental Differences between the Sexes." Joint meetings have also been arranged with the Physiological and Educational sections.

THE forest entomologist of the New York State College of Forestry at Syracuse is making a thorough study of the forest insects of New York. He has found that many kinds of insects injurious to trees are more numerous and are doing greater damage this year than usual. This is especially true of such insects as the tent caterpillars, aphids or plant lice and scale insects. This serious damage by insects to both fruit and forest trees during the past summer is due largely to the very mild weather of last winter, which allowed a large number of insects to pass the cold season successfully and the long rainless periods of spring and early summer, which enabled the young insects to get a good start in their life work of destroying vegetation. A number of reports have come in at Syracuse of the dying of the native hickory in different parts of the state. In most cases this is due to the hickory bark beetle, which is a very small boring insect, living between the inner bark and the sap wood of the hickory. This beetle makes a burrow in which it lays its eggs and from this burrow, smaller burrows are made in all directions by the young larvæ. The hickory tree, from a commercial standpoint, is doomed in New York state, unless very active work is done to prevent the spread of the insect. This can be done only by cutting the infested tree down and disposing of it in such a way as to kill all of the insects under the bark.

UNIVERSITY AND EDUCATIONAL NEWS

HAMPTON INSTITUTE receives $20,000 by the will of the late Robert C. Ogden.

THE thirteenth legislative assembly of Montana passed an act which provides that after the first day of July, 1913, the State University at Missoula, the College of Agriculture and Mechanic Arts at Bozeman, the School of Mines at Butte and the Normal School at Dillon, shall constitute the University of Montana, the control and supervision of which shall be vested in the State Board of Education. The State Board of Education has power, on the recommendation of the executive board of any of the institutions, to grant diplomas and to confer degrees on the gradu-

ates of all departments of the university. All of the engineering courses maintained by the state, with the exception of the course in mining engineering in the School of Mines at Butte, will be concentrated in the college at Bozeman. Dean A. W. Richter was transferred to Bozeman and becomes dean of engineering. Assistant Professors Wm. R. Plew and Philip S. Biegler were also transferred and added to the faculties of civil and electrical engineering, respectively.

Dr. Andrew Howard Ryan, for three years past instructor in physiology and pharmacology in the University of Pittsburgh, has accepted the chair of physiology in the medical department of the University of Alabama. He succeeds Dr. John Van de Erve, who recently resigned to take the chair of physiology in Marquette University, Milwaukee. Other appointments in the University of Alabama are: Dr. Howard H. Bell, of the University of Pennsylvania, full time assistant in the department of pathology; Dr. Jesse P. Chapman, instructor in orthopedic surgery; Dr. Percy J. Howard, associate professor of surgery; Dr. E. S. Sledge, instructor in radiography, and Dr. Julius G. Henry, instructor in medicine.

Dr. Wade H. Brown, professor of pathology in the University of North Carolina, Chapel Hill, has resigned, to accept service with the Rockefeller Institute of Medical Research, New York City, and has been succeeded by Dr. James A. Bullitt, late of the University of Mississippi.

Dr. Albert Einstein, docent for mathematical physics at the Zurich Technological Institute, known for his contributions to the theory of relativity, has been called to Berlin to succeed the late Professor J. H. van't Hoff.

DISCUSSION AND CORRESPONDENCE

COLOR CORRELATION IN COWPEAS

Some facts developed in my genetic investigations with cowpeas (*Vigna* species) are of interest in connection with the remarks of Professor J. K. Shaw, on page 126, concerning color correlation in garden beans. There are some interesting similarities and also interesting differences in these correlations as I have found them in the cowpea and as Professor Shaw finds them in the bean. I have, in most of the cases considered below, determined the particular Mendelian factor concerned in the correlation.

All varieties of cowpeas having coffee-colored seeds and all varieties having white or cream-colored seeds have white flowers and are devoid of anthocyan in stems and leaves. The flower color, which is due to an anthocyan, and the anthocyan in stems and leaves are dependent on two Mendelian color factors, one of which, apparently an enzyme, is the general factor for color in the seed coat of the cowpea. The other is the special factor for black which, when added to a variety having coffee-colored seeds, converts the seed color to black.

I have found three independent Mendelian factors for "eye" in the cowpea which, singly and together, give five distinct types of "eye." One of these factors, which gives the type of "eye" which I have designated the narrow "eye," also has the effect of inhibiting the development of anthocyan in the flowers, though it permits its development in stems and leaves. That is, the variety having the narrow "eye" has white flowers but has the pinkish-red or purplish color in certain portions of the stems and leaves. We apparently have here certain Mendelian factors which act differently in different parts of the plant, and this seems to be responsible for the correlation of the characters here discussed.

Cowpeas having any part of the seed coat black have anthocyan in the stems and leaves, and unless the factor for narrow "eye" is present there is also anthocyan in the flowers. Cowpea varieties having coffee-colored seeds have no anthocyan in stems, leaves or flowers. Cowpeas having buff or red seed coats may or may not have anthocyan in the stems and leaves and in the flowers according as the special factor for black or the factor for narrow "eye" is present or absent.

W. J. Spillman
U. S. Department of Agriculture

VARIATIONS IN THE EARTH'S MAGNETIC FIELD

OBSERVATIONS made in a tent on the lake shore in Mackinac County, Mich., during the last month have fully verified the results and conclusions published in my paper entitled "Local Magnetic Storms."

Cloud shadows diminish the permeability of the space within them in precisely the same way that the earth's shadow does at night. The molecules of air are ionized by solar radiation. They are then little magnets, which tend to set along the lines of force of the earth's field, in such a way as to add their magnetic effect to that of the earth's field. When solar radiation is cut off, the air molecules begin to return to their normal condition. Wind gusts and falling rain drops assist in this operation. They decrease the permeability.

When an iron bar is placed within a coil of wire carrying a current, its molecules are not quite so free to set in positions such that their magnetic effect is added to that of the coil. A blow from a wooden mallet then assists them. Its effect is directly the opposite of that produced by a gust of wind in air.

These results appear to furnish a rational explanation of the conditions which bring about local, daily and annual variations in the earth's magnetic field. Local variations are due to local variations in the weather. Clouds and sunshine, wind storms and rain, are the agents which bring about a continual swaying of the lines of force.

They also indicate an explanation of what causes the difference in permeability of solid matter.

In this work the needle was enclosed in an airtight case, and mounted on a silk fiber about 40 cm. in length. Its motion was damped. It was deflected at right angles to the magnetic meridian by magnets whose axes were at an angle of 45° with the meridian. The resultant field was partly compensated by bar magnets 120 cm. in length. All magnets were sealed within heavy rubber tubing, mounted in U-shaped supports, and enclosed in ice. The supporting table was a frame made of 2×4 inch timber, bolted together with brass bolts, and the legs of the structure were set two feet into solid clay and gravel soil. The frame was securely braced.

FRANCIS E. NIPHER

HESSEL, MICH.,
July 26, 1913

EXCUSING CLASS ABSENCES IN COLLEGE

THERE is no general uniformity in the matter of handling class absences in college. In some institutions the individual teachers still excuse for all absences in the course for which the teacher is responsible. In an increasing number of institutions the excusing power is centralized in some one office and in a large number of cases some form of the cut system is used. In some cases the student is allowed as many absences a semester from a course as the course recites times per week, that is, three absences from a three-hour course, four from a four-hour course, etc. In general the number of class cuts allowed seems to run as a minimum about 15 a semester—the number of absences allowed a semester in all courses approximating the number of recitation periods per week.

In cases where this minimum *is* allowed it means that 5½ per cent, approximately, of the class-room periods may be omitted by any or all students without any account being given for the absences.

A system such as this seems almost an invitation to a student to avail himself of the number of cuts allowed and in a large number of cases is so regarded.

In Oberlin College all class absences are reported to the dean of men and the dean of women, respectively. Each student must give an account to the proper officer of *all* absences.

The results during the semester ending in February, 1913, were as follows in the case of the college men: the average number of absences for each freshman was 6.1, for each sophomore 7.9, for each junior 7.5, for each senior 7.3. This includes absences for *all* reasons, sickness, absence on athletic teams, glee clubs, etc., and counts absences from *all* classes, including physical training. The record of no student is included who left college for any reason before the end of the semester.

The total number of men and absences were as follows during the semester just closed:

	Men	Total Absences	Average Absences per Man
Freshmen....	115	702	6.1
Sophomore....	81	662	7.9
Junior........	83	623	7.5
Senior..	79	580	7.3
	358	2,567	7.17

Of this total number of absences 431 were due to athletics. This includes not alone the absences of the members of teams, but also of students absent to attend games. This number amounts to 17 per cent. of all the absences, but is less than one half of one per cent. of the total number of class periods involved.

795 of the absences were due to sickness, or were so reported. These figures do not attempt to go back of the reasons given for failure to attend class. *At least* 795 absences were so accounted for. It is quite possible that the number should be larger and that the reason was not in every case noted in the record book. This number is 31 per cent. of the whole number of absences, and added to the 17 per cent. caused by athletics accounts for 48 per cent. of the whole number. Of the absences, 52 per cent., or an average of 3.7 per man, were accounted for by various other excuses.

In the practical handling of the excuses, upper-class men are excused without much question as to the quality of the excuse if the number of absences for the semester has not exceeded six to eight. If the number of hours per week for each man is estimated at 15, a normal amount, the total number of absences would amount to 2.6 per cent. of the class periods involved. Or, looking at it in another way, the average attendance of the men for the semester is 97.4 per cent.

The figures from which these percentages are derived are as follows:

$$\frac{\text{Men}}{358} \times \frac{\text{Classes per week}}{15} \times \frac{\text{Week per semester}}{18} = 96.660$$

Total number of absences = 2,567

Percentage of absences, 2.6 per cent.

If 15 cuts a semester is somewhere near the number usually allowed the following figures are of interest: of the 115 freshmen 103, or 90 per cent., had *less* than 15 absences; of the 81 sophomores 66, or 81 per cent., had *less* than 15 absences; of the 83 juniors 74, or 89 per cent., had *less* than 15 absences; of the 79 seniors 68, or 86 per cent., had *less* than 15 absences.

The writer submits these figures that they may be compared with the results in other institutions, especially those where some form of the cut system is in use. It is the feeling of the writer that the fact that *each* absence has to be accounted for acts as a deterrent in a large number of cases, when the student would easily absent himself under the cut system.

Each instructor is furnished with blanks and is asked to report the absences for each day. These blanks are deposited in boxes adjacent to the classroom and are collected and entered in the record by a clerk. The scheme to be effective must enlist the support and cooperation of all instructors. The instructors must, of course, attempt to see that all absences are reported. The figures given are for absences actually reported. It is recognized that, owing to human frailty, a certain number are not reported. That same lack exists in any system that has yet been devised. The percentage of absences not reported is, I believe, small. May we have figures from other institutions? The figures I have given here would seem to indicate that a smaller number of cuts might prove feasible in those institutions that use the cut system.

I doubt if we have any scientific basis for estimating the number of excuses that a man is normally entitled to receive during a semester. Perhaps some figures of this kind will give us a start toward such a basis.

E. A. Miller

Oberlin College

SCIENTIFIC BOOKS

The Infancy of Animals. By W. P. Pycraft. With 64 Plates on art paper and numerous Illustrations in the text. New York, Henry Holt and Company. 1913. Pp. xiv + 272.

It would be difficult to find a more fasci-

nating theme in the whole realm of zoology than "The Infancy of Animals," and we think that the author of the work under this head has succeeded admirably in a difficult task—that of presenting a generous measure of significant fact, with due regard to scientific accuracy, and in readable English. Students of the invertebrates might feel that he was hardly justified in saying that the "childhood" of animals was a subject which has been strangely neglected. Yet this criticism would apply to most of the higher animals, with which he is mainly concerned. Take from the shelf any standard work upon mammals or birds, and you will look in vain for any adequate accounts of the young in most of the species described. If one were to consult a large museum instead, with but few notable exceptions, this neglect of the juvenile period of life would be even more apparent.

The infantile, juvenile, or adolescent phases of animal life, whatever be the names by which we attempt to classify the post-embryonic phases of development, which lead to the adult state, are not only difficult to correlate with reference to the "accident" of birth, but they are often exceedingly difficult to study. In many cases, our meager information is due to want of opportunity, rather than to lack of effort. Students who have worked for months at the seashore in the vain endeavor to trace a difficult life history, or who have tramped unnumbered miles in search of a particular bird or beast, in order to study its young, certainly need no admonition on this score.

The early post-embryonic life of animals embraces a very large section of zoology and psychology, and is of equal importance for comparative anatomy and evolution. The reader will find anatomical and evolutionary problems freely discussed, but the psychology of behavior does not come within the aims of the present work. Of the fourteen chapters of text, all but two of which deal with vertebrates, the most noteworthy are the three devoted to birds (Young Birds in the Nursery, Coloration, and Young Birds and the Records of the Past, Chaps. V.–VII.), a field in which the author is well known by his excellent "History of Birds," and numerous special contributions. These, as well as the remaining sections, are filled with pertinent and interesting facts, drawn from a wide field, and are imbued with the spirit which, after learning how, is not satisfied until it knows why.

Of the many perplexing problems which the coloration of animals presents, the retention of stripes in the livery of the young and adult, or in that of the young alone, is of special interest to students of evolution. The author maintains the Darwinian thesis that this character of the young is reminiscent of an ancestral condition. The primitive striped pattern has often been allowed to persist in the early stages of life, because it was either a direct source of protection, or at least because it was not harmful. In other words the mantle of the forefather has been thrust upon the juvenile descendant to protect him, in the absence of its parents, and has often been left there when of no further use. This longitudinal striping, which is found in representatives of all the vertebrates, is not only more characteristic of the young than of the adult, but is more common in species which have retained the greatest number of primitive characters. In the course of growth the stripes tend to break up into spots, which may be retained, or disappear, when the animal becomes uniformly colored. The nestlings of the emu and cassowary, the most primitive of living birds, as the author shows, are more or less completely marked over the entire body with a series of light stripes, on a dark ground, but these marks disintegrate, giving way to an adult plumage of uniform tint. The same conditions are repeated in the unrelated grebes, and in other groups of birds where striped nestlings occur, these markings tend to break up into spots that may be retained or disappear. Similar phenomena occur in mammals. The leopard may be unable to change his spots, or the tiger his stripes, but the lion can, or has, for his cubs still bear the birth mark of an ancestral spotted state.

Admitting the power of selection, through variation and heredity, to effect such changes for the better protection of young and adult,

our difficulties of interpretation are not at an end. How, upon the same principles, shall we account for the rather startling exceptions which confront us at every turn—the zebra, for instance, "the noblest Roman of them all," so far as this kind of livery is concerned, in which not only the young, but both sexes, are striped all over. For untold ages, so far as we can judge, zebras have haunted the open, sun-scorched veldt of South and Southeast Africa, where their conspicuous coats, seen from afar, are the boldest advertisement possible to their numerous enemies; yet they managed to thrive, at least until the white man appeared upon the scene with a rifle, and no satisfactory solution of the meaning of their stripes has yet been offered. How then are we to account for an assumed striped ancestral livery in so many animals, whether young or adult? As Darwin remarked, since in the horse family both sexes are colored alike, there is no evidence of sexual selection here, and if stripes and spots originated as ornaments, how does it happen that so many animals in their present adult state have lost them?

The parental care and affection afforded to offspring, so strongly evinced in the mammal and bird, can be followed in all its various degrees of manifestation to invertebrates of very lowly estate. The author has recorded a number of remarkable instances in birds, wherein interpretation is difficult, and perhaps impossible without a much fuller knowledge of behavior in every direction than is now possessed.

Bats have been seen to capture prey, when loaded with their young, and many birds in times of stress are equally independent, not only transporting their young from place to place, but even transferring their eggs, though, excepting the gray cuckoo, well authenticated cases of egg-transport are extremely rare. The great northern diver or loon is an adept in thus dealing with its young, as is also the lesser grebe or dabchick, mentioned by the author. More remarkable still is the way in which woodcock will sometimes carry their nestlings to and fro, from nest to feeding grounds, holding them, as we are told, apparently between their legs, and possibly with the further aid of their long bill placed underneath for support.

The author raises a more vexed question in his descriptions of the diving and fishing habits of certain birds, and their methods of dealing with their prey, as to whether the young really receive direct and deliberate lessons from their parents in all these things. If we were to ask the preliminary question, whether animals that are directed so completely by instinct need a teacher of this sort, we should be obliged to answer plainly in the negative. In this respect, so far as we can see, the different species of birds stand very nearly at a level, and in every case instinct, perfected by practise, or corrected by individual experience, and often aided by imitation, seems amply sufficient to guide the majority aright in every important vital activity. "What flight is to the eagle," says the author, "diving is to the nestlings of the auk tribe, grebes, and divers. . . . In acquiring the art there can be no doubt but that the young are instructed by their parents. The adult razor-bill has been seen to take her nestling by the neck and dive with it, many times in succession; and as these excursions seem to be anything but pleasant at first, the young one often dives for a moment to dodge its zealous parent, thus effecting the end to be attained. Young grebes are certainly given lessons in diving, and also in catching fish" (p. 68). A description follows of what the author regards as a diving and fishing lesson given to a young grebe by its parent. Later he says: "Young birds of prey receive instruction first in the art of breaking up their food, and later in its capture," and Macpherson's interesting story of the golden eagle is quoted in confirmation of these ideas.

We are quite ready to believe that the remarkable behaviors of the species referred to in the preceding statements have been accurately reported, but we doubt if the interpretation, though apparently so obvious and natural, is really correct. Such interpretations do not fit, when we closely study be-

havior in other directions, and in other species of birds. They do not comport with the workings of instinct in the great avian class. Flight, diving, the capture of food and its treatment, all seem to be as certainly provided for in the inherited stock-in-trade, as either nest-building or song. Young gulls, up to the time they take to the water, beyond which I have never been able to watch them closely, certainly get no direct instruction in regard to their food, but plenty which is indirect, and from the time they desert the family preserve they feed abundantly on insects. The parent is not only *alma mater,* but the great quickener and director of inherited impulses in the young, while at the same time she is the most fascinating model for them to copy. Aside from bodily protection and other minor services, the lack of this parental factor is hardly appreciable in the incubator-reared chick, but is much more apparent in a hand-reared American robin or nestling of any other altricious species, where the transition between simply taking what drops from heaven, and going about to search for it, are more difficult to compass. The impulses are in any case natural, though they can not be forced. That there is a "school of the woods" we do not deny, but we regard it as an easy "school," in which the "teacher" has a natural gift to impart and the "pupil" an inherited tendency to receive.

It is gull-nature to dally with the food in the presence of the young, laying it on the ground and picking it up again, and even putting it back in the "pocket," if it is not quickly mastered, and it is gull chick-nature to follow every movement of the parent, putting head to the ground to get the food, when this is dropped. In such ways, perhaps, a useful lesson, in looking to the ground as an early source of food, is gradually instilled. But this is probably of small consequence, for most inexperienced birds peck instinctively at attractive objects, and all the more readily if these are in motion.

Young hawks, which we have taken from the nest before they were able to stand, and reared in cages, when first introduced to live prey, such as frogs, rats and pigeons, dealt with it in every case in the most uniform and precise manner, and this way was characteristic of their race. Before getting such food they will even seize chips and grass, and practise what we may call "play at catching frogs and mice." They will approach the chip cautiously, crouch, squeal, strike, seize, and spread over it as if it were really alive, inflicting blows upon it with the tearing, ripping-up motion, with which they would treat an actual frog or a piece of meat.

What then was such a bird as the grebe, referred to above, about, when unceremoniously ducking its youngsters? It might be that it was imparting a genuine lesson in diving, of the direct sort, that is, given with a motive, in recognition of its progeny's needs, but we have gone to this length to point out that this supposition does not exhaust all the possibilities. It might be that the parental instincts were on the wane, or that their sequence was disturbed, for many birds, of which the moor hen has been noted by Howard, instinctively drive off their young, as soon as they are able to shift for themselves, teasing, pecking, and harrying them unmercifully. It would be important to ascertain if the grebes ever display the same instinct. A wider knowledge of grebe-play, cleaning, and other instinctive procedure, might afford further suggestions.

We could refer to parallel and even more striking cases in illustration of the difficulties of interpretation. During courtship most birds perform antics of some sort, in the course of which they spread and move their wings and tail and erect their feathers, Since many, like the gay and lordly peacock, are richly decorated, what more obvious interpretation than that this spreading is a form of display, a showing off of all their finery, in order to charm the female. This, as is well known, was Darwin's interpretation, and formed the basis of his theory of sexual selection, or as it is now often called, preferential mating. But more recent and more exact studies upon the whole course of sexual behavior, of which I would cite particularly the illuminating work of

Howard on the British warblers, have shown that these spreading movements are typically reflex, and that they are common to many periods of excitement, so it is probable that they really have nothing to do with "charming" the female, in the sense in which this word is commonly understood. Even the dull cat-bird can be seen to spread before a prospective mate, and as Howard has shown, the presence of the female is not always necessary to excite such behavior during the mating period. Essentially the same movements are executed at the instance of sudden sounds, or of fear, not to speak of the spontaneous antics of the turkey gobbler, or even of the gaudy peacock, which, as Darwin acknowledged, will spread in the presence of poultry and swine.

In a chapter on Reptiles and their Progeny, the author refers to the ancient story of the viper "swallowing" her young in times of danger, with the remark that since this reptile is viviparous, many persons who had supposed that they had taken its young from the alimentary tract had really assisted at their birth. Whether there is any germ of truth at the root of this hoary belief, or whether it rightfully belongs among the vulgar errors to which Thomas Browne consigned it in the seventeenth century, we do not pretend to say, but the author's suggestion does not remove all the difficulties. Many American naturalists of repute have supported the contention that certain snakes do occasionally refuge their young in the throat or esophagus, and numerous American species, both venomous and nonvenomous, are included in the list. It is a matter of some historical interest that the American Association for the Advancement of Science, which met at Portland, Maine, in 1873, held in one of its sections a sort of convention on snakes. G. Browne Goode, who afterwards became the head of the United States National Museum, led the discussion, and F. W. Putnam, secretary of the Association, Theodore Gill, and other prominent naturalists took part in it. Goode's paper, which was suggested by a still earlier one by Putnam, in the *American Naturalist* for 1869, and was published in full in the Annual Reports of the society, was an attempt to show that many snakes give temporary refuge to their young, much as certain fishes are known to carry about and protect their eggs in their mouths. He received the support of all these men, in addition to that of one hundred other witnesses whom he considered reliable, including Sidney J. Smith, noted for his accuracy as a marine zoologist, and Edward Palmer, of the Smithsonian Institution. So strongly was this "viperine" story supported that Dr. Gill, in summing up the evidence, declared it was "sufficient to set the matter for ever at rest." This will illustrate in still another direction the difficulties of interpretation in animal behavior, whether actual or visionary. If such competent witnesses and judges were deceived, it must be due to some other cause than that which the author of "The Infancy of Animals" has adduced. It may be that the young of many snakes—and this is an idea which we owe to a somewhat old but excellent work by Miss Hopley—respond instinctively to the calls of their parent by running towards her head and afterwards concealing themselves under her body. If young snakes were thought to be seen running into the mouth, it would require but little imagination to see them pop out again, the mind having already, perhaps, pictured such a scene in advance. Otherwise, so far as we can see, if we discredit all these accounts, we must continue to regard the snake as the fruitful cause of all moral obliquity.

The author's illustrations, particularly the photographs, are excellent, and add distinctively to the attraction of a valuable and interesting work.

FRANCIS H. HERRICK

LAUSANNE,
June 20, 1913

Explosives. A Synoptic and Critical Treatment of the Subject as gathered from Various Sources. By Dr. H. BRUNSWIG. Translated and annotated by CHARLES E. MUNROE, Ph.D., LL.D., and ALTON L. KIBLER, M.S., Ph.D.

The excuse for producing a new book in the

field of explosives is well given in the preface: to bring together more closely the science and practise of the subject; to establish a closer cooperation between the scientist and the technologist. In this the author has succeeded most remarkably well. The important modern explosives are carefully reviewed and arranged according to chemical and physical views now held. Theoretical and mathematical discussions have been omitted, which makes the book valuable to the technologist who as a rule has troubles enough without trying to keep in practise on advanced mathematics.

In chapter one there is given a clear outline of the elementary principles relating to the general behavior of explosives. Chapters two, three and four treat of velocity, temperature and pressure produced by explosives on combustion. An excellent discussion of the products of explosive reactions as influenced by temperature and pressure is given in chapter five. Chapter six treats of intensity and velocity of the explosive impulse. Chapter seven is of special importance to miners and ordnance officers since it treats of the flame of an explosion. Igniters, fuses, detonators and fulminates are described in chapter eight. In chapter nine there is a brief but excellent discussion of black and smokeless powders. Blasting explosives in chapter ten are fully discussed, including hints for handling, use and destruction of explosives generally.

A valuable feature of the book is the splendid list of references to literature on explosives and related subjects. The work, which on the whole is excellent, has lost nothing by translation. Works of this character are frequently ruined by translators, either on account of lack of knowledge of the foreign language or unfamiliarity of the subject. In this case the translators show a thorough knowledge of German, and surely Dr. Munroe is more familiar with explosives than any one else in this country. It is gratifying to note that attention is called to the fact that the term "nitroglycerine" is not in accordance with present-day chemical nomenclature. Why not discard also the name "nitrocellulose"? The latter is a nitrate just as much as the former. On page 161 in equation one there should be shown six carbon dioxids instead of two, and on page 162 where the decomposition of picric acid is shown six molecules, not two, of hydrogen are formed. Nothing further remains to be said except that no explosives library is up to date without this work.

A. P. SY

NOTES ON METEOROLOGY AND CLIMATOLOGY

THE SOLAR CONSTANT OF RADIATION

VOLUME III. of the Annals of the Astrophysical Observatory of the Smithsonian Institution has just appeared (a great quarto volume of 241 pages). As a result of recent investigations of the intensity of solar radiation, these noteworthy results have been obtained: (1) That the mean value of the solar constant of radiation for the epoch 1905–1912 is 1.929 calories per square centimeter per minute; (2) an increase in the solar constant by 0.07 calories per square centimeter per minute is accompanied by an increase of 100 in sun-spot numbers; (3) numerous, almost simultaneous measurements of the solar constant at Mount Wilson, California, and at Bassour, Algeria, would indicate that the intensity of solar radiation experiences an irregular change which frequently exceeds 0.07 calories per square centimeter per minute and which follows a ten-day period; (4) indications of two entirely independent phenomena makes it reasonable to believe that the variations in the solar constant are caused by the sun itself and probably not by meteoric dust or other phenomena between the sun and earth.[1]

WEST INDIA HURRICANES

IN a recent Weather Bureau bulletin entitled "Hurricanes of the West Indies,"[2] Professor Oliver L. Fassig gives the results of a thorough

[1] C. G. Abbot, F. E. Fowle and L. B. Aldrich, "Die Solarkonstante und ihre Schwankungen," *Meteorologische Zeitschrift*, pp. 257–261, June, 1913.

[2] Bulletin X., U. S. Weather Bureau, March 29, 1913, quarto, 28 pp., 25 plates.

investigation of 134 West India hurricanes occurring in the 36 years 1876–1911. The area visited by these storms includes the Gulf of Mexico, the Caribbean Sea and the tropical ocean for a few hundred miles east of the West Indies and Florida,—thus the routes leading to and from the Panama Canal on the Atlantic side will lie for a great distance in the heart of the hurricane zone. There are two main hurricane paths, one following the inside Gulf Stream route and the other the line of the northward Atlantic drift off the north and east coasts of the Greater Antilles and Florida. The former is most frequented by the cyclones in June and July and the latter in August, September and October. In these last three months 88 per cent. of the 134 cyclones occurred. Their tracks are normally parabolic, open to the east. The average rate of movement on the first branch (northwestward) and during the "recurve" (northward), is 11 miles per hour. On the second branch (moving northeast) the mean velocity increases to 16 miles per hour. The mean duration was 5.8 days (maximum 19, minimum 1 day). The number of West India hurricanes in the 20 years 1880–1899 was 86, as against 418 typhoons in the west Pacific and 184 cyclones in the Bay of Bengal during the same period. Professor Fassig considers West India hurricanes as mainly the result of general atmospheric movements and not of local differences in temperature. When in summer the equatorial belt of calms has moved some distance north of the equator, the deflective action of the earth's rotation is sufficient to produce a cyclone when an adequate initial impulse comes from the somewhat conflicting trade winds north and south of the doldrums.

HUMIDITY AND FROST DAMAGE

Professor A. G. McAdie in the *Monthly Weather Review* for April, 1913, in an article entitled "Frost Studies—Determining Probable Minimum Temperatures," points out that in frost damage to plants the relative humidity of the air is a very important factor. For instance, in the frost of January 4–7, 1913, in southern California the dryness of the air favored rapid radiation and evaporation, causing damage to plants not only on account of the low temperature but also through serious interference with proper plant functions, especially in connection with transpiration, which became injuriously rapid.

On another page of this number, Mr. E. S Nichols, local forecaster at Grand Junction, Colo., in connection with a damaging frost on April 23 also calls attention to the fact that on dry frosty nights greater injury is done than on moist ones with equal air temperatures. He has accordingly warned fruitgrowers in his district to begin smudging on dry frosty nights at higher temperatures than on damp ones.[3]

CLOUDINESS AND SUNSHINE OF NORTH AMERICA

An important contribution to the climatology of North America entitled "Bewölkungsverhältnisse und Sonnenscheindauer von Nordamerika," by Arthur Gläser, has recently appeared.[4] The area covered is limited on the north on account of lack of observations to include only southern Canada. There are three general regions where the mean annual cloudiness is in excess of 60 per cent.—around Puget Sound, the Great Lakes and the Canadian Maritime Provinces. A minimum of less than 20 per cent. occurs in the region about the lower Colorado River in southwestern Arizona and southeastern California. This relative distribution in general remains the same throughout the year. Maximum cloudiness for southern and eastern United States and the Pacific coast including the Great Basin comes in winter; for the Great Plains, in spring; for New Mexico, Arizona, most of Mexico and Florida, in summer; and for the country roughly north of latitude 43 degrees and east of the one hundredth meridian, in November. Minimum cloudiness comes in winter over central Canada; in spring over most of Mexico

[3] See also E. A. Beals, "Forecasting Frost in the North Pacific States," Weather Bureau Bull. No. 41, 1912.

[4] Aus dem *Archiv der Deutschen Seewarte*, XXXV., 1912, Nr. 1, quarto, 63 pp., 22 figs., 7 charts.

and Florida; in summer throughout northern United States and the Great Basin; and in fall over the California coast, central Rockies, southern and eastern United States. The duration of sunshine is about the reverse of the cloudiness indicated, for the cloudiness records are practically only from observations in the daytime.

Previous cloudiness charts for the United States were published (1) in 1890 by General A. W. Greely, of the Signal Service; (2) in 1898 by the Weather Bureau;[5] (3) in 1911 by K. McR. Clark.[6]

AUSTRALIAN METEOROLOGY

THE Australian Weather Service has recently published new monthly and annual temperature and rainfall charts of Australia and Tasmania based on observation series from twenty to forty years in length. These charts correspond closely with earlier ones except that the annual isotherms sweep north in the center of Australia instead of south and the isohyts show the rainfall in greater detail. An annual rainfall of less than 5 inches is indicated in South Australia and as high as 140 inches on the Queensland coast. Commonwealth Meteorologist H. A. Hunt has invented a novel rotary diagram called a "rainfall clock," which indicates in a striking manner the progressive monthly changes of Australian rainfall.

The remarkable constancy and regularity of Australian weather has led Mr. Hunt to suggest the foundation of international meteorological observatories there for purposes of research in the fundamental problems of dynamic meteorology.[7]

NOTES

HOFRAT PROFESSOR DR. JULIUS VON HANN writes that a third edition of his great "Lehrbuch der Meteorologie" will soon begin to appear. It is coming out in sections to make its purchase easier. He expects the work to be complete in the fall of 1914. The first edition appeared in 1901 and the second in 1906. From 1908–1911 Dr. von Hann published the third edition of his great "Handbuch der Klimatologie" in three volumes. These two magnificent works are second to none in the realm of meteorology and climatology.

THE Royal Academy of Holland has conferred the Buys-Ballot Medal on Dr. H. Hergesell in recognition of his service in the investigations of the upper air in the subtropics and arctic, and as head of the International Commission for Scientific Aeronautics. In 1903 this medal was conferred on Professors Assmann and Berson, and in 1893 on Dr. von Hann.

DIRECTOR M. A. RYKATCHEW, of the Nicholas Central Physical Observatory, at St. Petersburg, retired on May 7, after having served 46 years, of which the last 17 were as director.

IN the report of the Chief of the Weather Bureau for 1911–12, recently issued, mention is made of preparations for proposed anemometer tests by Professor C. F. Marvin, now Chief. A whirling machine with an arm thirty feet long and capable of producing wind velocities up to 70 or 80 miles per hour will be used. There will be tests carried on also in a "wind tunnel" through which with blowers a current of air exceeding 100 miles per hour can be forced. These tests are for the purpose of correcting the standard Weather Bureau anemometers to record true wind velocities instead of some 18 per cent. too high as in the past and at present.

CHARLES F. BROOKS
BLUE HILL METEOROLOGICAL OBSERVATORY

[5] Report of the Chief of the Weather Bureau, 1896–97.

[6] *Quarterly Journal of the Royal Meteorological Society*, April, 1911, pp. 169–175.

[7] See *Nature*, London, Vol. 91, pp. 355, 435–436, 489.

SPECIAL ARTICLES

THE REDISCOVERY OF PERIDERMIUM PYRIFORME PECK

THE name *Peridermium pyriforme* was proposed by Peck in 1875 for a blister rust growing "on pine limbs in the spring, Newfield, New Jersey." In his original description Peck laid emphasis on the form of the spores which he described as "obovate, pyriform, or oblong-

pyriform, acuminate below, .0015–.0025 inch long." So far as published reports show, no specimen of *Peridermium* has been recorded since that time having spores of this sort. Among mycologists it generally has been assumed that there must have been some error about Peck's description, and the name has been made to apply to a species having the ordinary small ellipsoid spores. The species to which the name has been thus applied is the one which has been culturally connected with *Cronartium Comptoniæ*.

After giving some attention to the matter several years ago the writers came to the conclusion that in Peck's original examination he possibly mistook some of the smaller peridial cells for spores.[1] In studying fresh specimens recently communicated to us from British Columbia, by W. P. Fraser, and from Colorado, by E. Bethel, we have found large pyriform cells which agree exactly in shape and size with the spores of the original description of *Peridermium pyriforme*. It is very evident that in these specimens they can not be peridial cells, for the peridial tissue is present and is composed of very different cells. There seems to be little doubt that we are dealing here with a striking species, very aptly named *Peridermium pyriforme* so many years ago, but which has been unrecognized ever since, while the name has been misapplied. Examination of our herbarium shows that there are a number of other specimens belonging here which had been erroneously, and carelessly, placed under other species. In addition to the three above-mentioned localities we have specimens from Wisconsin, South Dakota, Washington and Alberta. The range for the species is thus seen to be northern United States and southern Canada from ocean to ocean.

Having established the existence of a characteristic heterœcious form of wide geographical range, the question of the alternate phase becomes of immediate interest. Judging from analogy and distribution, together with some field observations, we suggest with much confidence that *Peridermium pyriforme* may be connected with *Cronartium comandræ*.

[1] See *Bull. Torrey Bot. Club*, 33: 420, 1906.

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Frank D. Kern

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July 15, 1913

A WINE-RED SUNFLOWER

In *Popular Science Monthly*, April, 1912, I described the finding and subsequent development of the red sunflower. The darker form predicted for 1912 duly appeared, but most of the intensely red types were bicolored, with the ends of the rays yellow. This is ascribed to the fact that the wild plant (var. *lenticularis*) carries a factor for marking, which is not clearly apparent until joined by the factor for red. In the orange or yellow rayed plants nothing more is apparent to the eye than a deepening of the color on the basal part, not distinctly defined or very readily noticeable. In photographs, however, the marking comes out, as is well shown in Dreer's "Garden Book," 1912, p. 221, for the perennial species. One would imagine from Dreer's figures of "Wolley Dod" and "multiflorus maximus" that the rays were bicolored. A much more striking illustration is given by Mr. G. N. Collins,[1] where *Bidens heterophylla* appears to have strongly bicolored rays when photographed in the ordinary way, but when photographed on an orthochromatic plate with a color screen does not appear bicolored at all. To the eye "the difference in color between the base and tip of the rays is barely perceptible."

We obtained from Sutton, of Reading, England, a variety of *Helianthus annuus* with very dark disc and pale primrose yellow rays. It is a tall, upright form, with the ends of the involucral bracts longer than usual. The seeds are black, or nearly. This plant, which comes quite true from seed, is called by Sutton, "Primrose Perfection"; we will call it var. *primulinus*.

In our red sunflowers so far obtained, the red, however bright, was always chestnut, as the result of the orange background. We saw

[1] *Plant World*, November, 1900, plate VII.

at once that if we could get the red (anthocyan) on the primrose background, we should have a quite new and more rosy color. In the summer of 1912 we accordingly crossed the reds with *primulinus*, and obtained a quantity of seed. The *primulinus* was used as the seed plant. As orange was sure to be dominant over primrose (or absence of orange), we could not expect to see our new variety until the F_2 generation. In order to hasten matters, we raised the F_1 generation indoors during the winter, and got enough seed to produce quite a series of plants. The F_1 plants did not differ in any respect from the reds to which we were accustomed, all having a rich orange-yellow background. Some, especially in the larger series now growing in the garden, show extremely rich and deep red colors, so that we should take them for homozygous reds if we did not know otherwise. On July 16 the first of the F_2 plants came into flower, and we were pleased to see that the rays had an entirely new shade of color, wine red on a primrose background. The first one, probably heterozygous for red, was rather dilutely colored, but we now have plants showing rays of a very rich deep wine red, with variable primrose tips. This new variety may be named *vinosus*. It is certainly interesting to obtain in this way an entirely new color, which nevertheless is due entirely to the redistribution of previously known factors, and which could thus be predicted in advance. Up to the time of writing, 21 F_2 plants have bloomed, of which 12 are red (of the chestnut type, of several minor varieties, as suffused and bicolored), 8 are *vinosus*, and one is pure primrose like the grandmaternal ancestor. This exactly agrees with the theoretical expectation as regards the reds and the primrose, but we have so far twice as many *vinosus* as expected, and no plain orange-yellows, of which there should be three or four. Probably when all the plants are in bloom the result will agree more exactly with the expectation.[2]

[2] *Postscript*. A census taken August 9 gives 71 red (chestnut), 19 yellow, 25 vinous and 8 primrose. The theoretical expectation for this number is 69 red, 23 yellow, 23 vinous and 8 primrose.

We have obtained a number of other varieties, which will be fully described at some other time. One curious one, which I call *tortuosus*, has the apical half of the rays twisted, as though in curl-papers. We have this both in the plain orange yellow and rich chestnut red with yellow tips, in each case the disc being dark. Similar forms have been obtained at other times by horticulturists.

A collection of seeds shows extraordinary variability in form and color; it would hardly be too much to say that the seeds are less alike than the resulting plants. Thus the tall primrose (*primulinus*) has black or nearly black seeds, Sutton's double primrose has gray seeds streaked with white, while there is a strain of dwarf primrose with perfectly white seeds. Seeds from any one plant are practically uniform, and we do not find any evidence that the pollen used affects the appearance of the resulting seed.

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July 22, 1913

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 512th meeting of the Biological Society of Washington was held in the assembly hall of the Cosmos Club, April 19, 1913, with Vice-president Hay in the chair and about 30 persons present.

Under the heading "Brief Notes and Exhibition of Specimens," Henry Talbott exhibited an unusually large tooth of the fossil shark, *Carcharodon megelodon* from South Carolina and by way of comparison the much smaller teeth of *Odontaspes* from Chesapeake Beach, Md., and made remarks on these sharks.

Wells W. Cooke made remarks on the spring migration, noting that the yellowthroat, redstart, wood thrush and catbird had arrived three days ahead of schedule time.

The regular program consisted of a communication by C. D. Marsh, entitled "Stock Poisoning by Larkspur." He stated that ranchmen of the west had long claimed losses of stock due to larkspur, and on scientific inquiry had found their observations correct, and that the monetary loss was considerable. Although larkspur occurs in other parts of the world, it apparently only causes trouble in the western United States. The average

mortality in affected areas of the west is from 3 to 5 per cent., but as many as 20 head out of a herd of 200 have been fatally poisoned in twenty-four hours. The low larkspur appears to be always dangerous, but the tall only becomes poisonous in August after the fruit matures. The poison is a cumulative one and requires from 3 to 10 per cent. of the animal's body weight of larkspur plant to cause death or alarming symptoms. The symptoms consist of general discomfort, nausea, constipation, a characteristic arching of the back and sudden collapse, followed by partial recovery and a repetition of similar attacks, and if the case is a fatal one, to end in respiratory paralysis and death by asphyxia. Animals do not become immune to the poison. Horses may be experimentally poisoned, but when feeding on the range do not eat into a patch of larkspur enough to consume a toxic quantity. Sheep are naturally immune to the poison and may be fed a continuous diet of little else than larkspur without showing any symptoms. The cowboy's treatment of the disease is bleeding, but the proportion of recoveries by this method is not greater than in natural recovery. Rational treatment consists in placing the poisoned animal on sloping ground with the head upward so that the abdominal viscera fall back from the thoracic organs. Drug treatment consists of eserine, pilocarpine and strychnine administered hypodermically. Under this method 96 per cent. of poisoned animals recover. Alcohol is also effective, but less practical. The paper was profusely ilustrated by excellent lantern slides, showing the larkspur in detail and on ranges, and numerous animals in various stages of poisoning. The paper was discussed by Messrs. Bailey, Weed, Hitchcock, Gill, Lyon and others.

THE 513th regular meeting of the Biological Society of Washington was held in the assembly hall of the Cosmos Club May 3, 1913, at 8 P.M., with President Nelson in the chair and 56 persons present.

Under the heading "Brief Notes and Exhibition of Specimens," Dr. H. M. Smith called attention to a large whale shark captured during the past year in Florida waters. It originally measured 38 feet in length, but as now mounted, 45 feet; it is being exhibited as a curiosity. Pictures of this shark were exhibited and extracts from a letter by the captor read. Dr. Smith's remarks were discussed by the chair and by Dr. Gill.

The regular program consisted of two communications by Dr. C. Hart Merriam and one by Edmund Heller.

I. "The Remarkable Extinct Fauna of Southern California revealed in the Asphalt Deposits near Los Angeles." Dr. Merriam remarked that asphalt had been known in this region to the Indians for thousands of years and was mentioned by the early Spanish padres. Although remains of animals in the asphalt deposits had been known since about the middle of the last century they have only lately been extensively studied by Dr. J. C. Merriam, of the University of California. The viscous asphalt appears to have acted as a natural trap, first entangling certain birds and mammals, and then these captured animals acting as bait to larger predatory forms. The remains may be roughly divided into three groups: (1) birds, some still existing, but mostly extinct, among them, hawks, 8 genera of eagles, vultures, including both North and South American condors, a condor-like bird, *Teratornis* of huge size, owls, ravens, herons, a peacock; (2) small mammals, as spermophiles, kangaroo rats, etc., and small carnivorous forms as weasels, skunks, badgers, bobcats, gray foxes; (3) large mammals, as deer, antelopes, buffaloes, elephants, mastodons, glyptodons, and large predatory forms, as wolves, mountain lions, giant lions, saber-toothed tigers and bears. Often several individuals of carnivorous forms, as giant wolves, saber-toothed tigers are associated with a single large ruminant. Discussed by Messrs. Gill, Hay and others.

II. "Notes on the Big Bears of North America." The speaker commented on the lack of adequate material for a systematic study of these bears. The black bear and allied forms he regarded as constituting a distinct genus from the brown and grizzly bears belonging to the genus *Ursus*, about 40 forms of which could be recognized as inhabiting the North American continent and adjacent islands.

III. "Distribution of Game Animals in Africa." Mr. Heller spoke of the life zones and areas of East Africa, illustrating the subject with maps, views of topography and characteristic mammals. The following areas, based mainly upon watersheds, were recognized: West Nile, East Nile, Uganda, East African, Abyssinian; and these life zones: Congo Forest, Tropical, Nyika, Highland Veldt, Highland Forest.

M. W. LYON, JR.,
Recording Secretary pro tem.

SCIENCE

FRIDAY, SEPTEMBER 5, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ORBITS OF FREELY FALLING BODIES

THE path described by a body falling freely from a considerable height above the surface of the earth presents a problem of interest alike to the mathematical and to the experimental physicist. The former sees in it a capital application of the principles of "relative motion"[1] and the latter sees in it a promising way of demonstrating the rotation of the earth. It has attracted perennial attention for more than a century and has been frequently referred to in this journal during the past decade.

The mechanical aspects of this problem were first carefully considered by Gauss and Laplace one hundred and ten years ago. Gauss's equations of motion for a falling body were furnished in a letter to Benzenberg, who was interested especially in the proper interpretation of experimental results. Gauss's solution of the problem is now accessible in the fifth volume of his collected works. He concluded that in addition to the obvious easterly deviation there should be a small meridional deviation towards the equator from the plumb line defined by a bob suspended from the initial position of the body and normal to some plane of reference below. It seems probable that this latter conclusion prompted Laplace to reinvestigate the subject, for he published a very remarkable paper in May, 1803, in the *Bulletin de la*

[1] This means only that account must be taken of the variations in position of some of the axes or planes of reference with the lapse of time. Why such motion should have been called "relative" and the less complex motion called "absolute" is a question worthy of investigation in the history of mechanics.

Société Philomatique, in which he invites special attention to his conclusion that there is no meridional deviation towards the equator. In view of this discrepancy between these preeminent authors it is a surprising circumstance that nearly all subsequent writers on the subject should have followed Gauss; and it is still more surprising that the more comprehensive and more suggestive, though more difficult, treatment of the problem by Laplace should have been little noticed and less followed by recent authors. Since the appearance of the papers just referred to by Gauss and Laplace only one author, until quite recently, appears to have considered the subject worthy of an independent investigation. This author is Poisson, who published in 1838 an important memoir on the theory of gunnery (in the *Journal de l'École Polytechnique,* Tome XVI.) of which a freely falling body presents a special case. As regards the meridional deviation in question Poisson goes one step further than Gauss and Laplace and leads us to infer (correctly) that his investigation shows no deviation either towards or away from the equator.

My attention was called to this subject about ten years ago, chiefly through the communications concerning it published in this journal by Professor Cajori and Professor E. H. Hall. A casual reading of the papers of Gauss, Laplace and Poisson indicated that they ought all to agree essentially, since they all limit themselves to terms of the first order of approximation of the small quantities involved, especially the angular velocity of the earth, which is obviously a fundamental factor in any solution of the problem. In the meantime, other occupations have led me to neglect this branch of geophysics until my attention was reattracted to it by the suggestive papers of Professor William H. Roever published recently in the *Transactions of the American Mathematical Society.*[2] A preliminary survey of the subject indicated that the obscurities and the discrepancies presented by it could be removed only by an independent investigation founded on present-day knowledge of geodesy. Such an investigation has been made and is now available to the mathematical physicist in Nos. 651–652 of the *Astronomical Journal* (August 4, 1913) under the title "The Orbits of Freely Falling Bodies." The object of this communication is to explain briefly for the information of the general reader the salient features of the subject, the sources of its obscurities, the requirements of a precise and correct determination of the orbits in question, the new results reached, and the reasons why they differ in certain important respects from those hitherto considered valid.

The motion of a falling body depends on three elements, namely: (1) the rotation of the earth; (2) the attraction of the earth; and (3) the difference between geocentric and geographic latitude. The effect of rotation is expressed in the equations of motion of a falling body by terms involving both the first and the second powers of the earth's angular velocity. In general, following Gauss, Laplace and Poisson, terms in the second power of this velocity have been neglected. It turns out that the meridional deviation is a term of the second order in this velocity and other quantities of the same order. Hence it failed to appear in the investigations of the above-named authors, or appeared only as a mathematical fiction and with the wrong

[2] "The Southerly Deviation of Falling Bodies," Vol. XII., No. 3, July, 1911; and "The Southerly and Easterly Deviations of Falling Bodies in an Unsymmetrical Gravitational Field," Vol. XIII., No. 4, October, 1912.

sign in the case of Gauss. The effect of the attraction of the earth presents difficulty, for the earth is not centrobaric, though many authors have assumed it to be such. Gauss and Laplace undoubtedly understood the nature of this difficulty: Laplace's paper (referred to above), is, indeed, entirely satisfactory even now so far as its generalities are concerned. But the necessary observational knowledge, since accumulated, was not available to these pioneers. Each of them was justified, perhaps, in assuming that the effect of the square of the angular velocity would be negligible and that the attraction would be sensibly what has been generally, but now quite vaguely and inappropriately, called "gravity" or "acceleration of gravity," and expressed by the letter g. But this attraction varies certainly with the latitude of the position of the falling body and possibly also with its longitude, and it is not identical with the resultant acceleration due to the attraction and to the rotation of the earth. In respect to both of these points the details of the papers of Gauss, Laplace and Poisson along with the papers of their followers, are all, so far as I am aware, not only obscure, but inadequate. Closely related to the question of the earth's attraction of a falling body is the distinction between its varying geocentric latitude and the constant geographical latitude of the plumb line to which the orbit of the body is referred. This distinction is essential to a correct determination of the meridional deviation, but its fundamental importance does not appear to have been recognized hitherto.

Failure on the part of the earlier authors to perceive the essential rôles of these elements and a tendency to avoid the complications they entail in dealing with the differential equations of motion, account completely for the obscurities and the confusion which initially beset the modern reader who attempts to understand the present extensive literature of this subject. The admirably conceived investigation of Laplace, since published as Chapitre V., Tome IV., of his Mécanique Céléste, presents additional difficulties by reason of his autocratic and unnecessary neglect of terms, without assigning their relative magnitudes, and by reason of his ready suppression, after the fashion of his day, of the identity of any quantity by calling it unity. Following Gauss, many recent authors also after neglecting terms of the second order in their equations of motion, have proceeded to get such terms by a purely mathematical process which has no warrant in the physical circumstances of the case. It has been necessary, therefore, in order to remove the prevailing uncertainties of the subject, to reinvestigate it, avoiding precedent and visualizing the conditions of the problem in the light of the more recent developments of physical geodesy rather than in the light of the foundations of this science laid so largely and so effectively by Gauss, Laplace and Poisson a century ago.

Accordingly, the equations of motion of the falling body are established without neglect of any terms which belong to them, and no terms in the integration of these equations are neglected without precise specification of their relative magnitudes. The energy method of Lagrange is followed in establishing the equations of motion, partly because it is specially adapted to the case and partly because it does not appear to have been used for this purpose hitherto. The position of the body is defined by reference to four sets of axes, and the equations of motion for each of three of these sets are derived and integrated so as to include all terms of the second order. These latter depend not only on the square

of the angular velocity of the earth, but on its attraction and on the difference between the geocentric and the geographic latitudes of the point in which a line drawn through the initial position of the body and normal to some plane of reference below pierces this plane. The three sets of equations of motion just referred to are expressed in terms (1) of the polar coordinates of the body (r, ψ, λ), r denoting radius vector from the center of the earth, ψ geocentric latitude and λ longitude from a principal equatorial axis of inertia of the earth; (2) of the rectangular coordinates (ξ, η, ζ), with origin at the point of intersection of that plumb line through the initial position of the body which is perpendicular to the horizontal plane of reference below, with distance ξ measured in this horizontal plane and parallel to the meridian plane through the initial position of the body, positively towards the equator, with distance η positive towards the east and normal to the initial meridian plane, and with distance ζ positive upwards and parallel to the normal at the origin; (3) of the orthogonal coordinates (η, ρ, σ), giving the distance η of the body east of the initial meridian plane, the distance ρ of η from the earth's axis of figure and the distance σ of the body from the plane of the earth's equator. It is thus practicable not only to approach the problem by different routes and to check all steps in the processes of solution, but also to see at once wherein the results reached differ from the conflicting results hitherto published.

Of the three sets of equations of motion, that for the last, or that for the coordinates η, ρ, σ, is the simplest. The integrals of this set (new to the subject, so far as I am aware) give the distance σ to a high order of approximation as a simple harmonic function whose amplitude is the initial value of σ; while the distances η and ρ are given with equal precision by sums respectively of two simple harmonic functions of two different angles. It is remarkable also that the diminution of the radius vector r and the easterly deviation η are each expressed with precision by a single hyperbolic term. In general, the system of coordinates r, ψ, λ is most convenient for the purposes of computation. But the equations for interconversion of all of the sets of coordinates are given in detail in the mathematical paper referred to.

It is shown that the meridional deviation specified by the ordinate ξ is always negative, or that this deviation is always towards the adjacent pole in either hemisphere instead of towards the equator as hitherto supposed. For a fall of 10 seconds, or 490.24 meters (in vacuo), in latitude 45° the meridional deviation would be 3.03 centimeters, and the easterly deviation 16.85 centimeters. These two deviations are proportional approximately to the square and to the cube, respectively, of the time of fall.

My investigation is subject to two voluntary restrictions and to one limitation dependent on our present lack of observational information in geodesy. The first restriction lies in the neglect of the effect of atmospheric resistance on the orbit of the falling body. This effect is known from the work of Laplace, Poisson and others to be very small, since the path of the body throughout its fall is everywhere very nearly normal to the stratification of the air. For such falls as may be practicable for observation this effect is negligible, especially in comparison with the effects of currents of air and of lateral displacement due to the rolling of the smoothest spheres.[3] The other restriction lies in solving the

[3] I consider it quite impracticable to make any conclusive experiments on the deviation of spheres falling in air.

problem of fall for the case in which the orbit is wholly external to the earth. The more complex case of a body falling down a bore-hole, or mine shaft, or the case in which the orbit lies partly without and partly within the earth's crust, is not considered. In view of the difficulties in the way of experimental applications it has not seemed to me worth while to extend the paper so as to include the additions and the modifications essential to these more complex cases.

The limitation referred to arises from insufficient knowledge as to the distribution of the earth's mass in respect to the plane of the equator. For nearly a century it has been generally assumed that this distribution is such as to make the two principal equatorial moments of inertia of the earth equal. In the absence of adequate information on this point I have followed the current assumption, the effect of which in the case of a falling body is to make its orbit independent of longitude. But I do not believe this assumption is justified, and I would take this occasion to urge upon astronomers and geodesists the great need for the settlement of this and other questions in geophysics of a systematic gravimetric survey of the earth. Any inequality in these moments of inertia produces also a necessary prolongation of the Eulerian cycle which figures so prominently in the theory of latitude variations, and it appears to me highly probable that this prolongation is due quite as much to that inequality as to an elastic yielding of the mass of the earth. R. S. WOODWARD

FUNCTIONS AND LIMITATIONS OF THE GOVERNING BOARD[1]

THE development of higher education in America during the past quarter of a century has no parallel in history. In no other country have private citizens lavished upon universities so many millions for equipment and endowment. In no other country have universities received from state or national governments so many millions for maintenance. The annual income of Columbia University is greater than the combined incomes of Oxford with her score of colleges—Oxford with a thousand years behind her, the great national university of England. The University of Illinois, which twenty-five years ago was scarcely the equal in income or equipment of a first class agricultural high school of the present day, has an annual income far greater than that of the great national university of Germany, at Berlin, an income greater than that of the Sorbonne—in short, an income far greater than is claimed for any of the ancient and famous universities of the Old World. More money—one may venture to assert, the figures are not at hand—has been spent upon buildings and equipment for the University of Chicago during the past fifteen years than has been spent upon the buildings and equipment for the University of Bologne throughout its thousand years of history.

But after all, vast endowments and stately halls of granite or marble do not make a university. A real university is the creation of great men. Only in an inspiring environment which lures to it real scholars and thinkers may a great university be created or maintained. The finer spirits of the republic of letters will shun and hate the stifling atmosphere of a university, no matter how vast its endowment or how splendid its buildings, that does not give its professors a feeling of security and of freedom.

Does the American university offer to its teachers such an environment? Some doubtless do, the vast majority unquestion-

[1] Speech delivered (July 9) before the National Educational Association, at Salt Lake City, by Edwin Boone Craighead, LL.D., D.C.L., president of the University of Montana.

ably do not. For reasons not hard to discern, many of our ablest scholars and bravest spirits have come to hate the very atmosphere of the university and are longing to escape from it and to turn their steps toward the big wide world of struggle and strife, where men are at least free to carve out their own destinies in their own way and by their own efforts. In no other civilized country have the great scholars and teachers so little influence in university administration. For many centuries Oxford has in the main been governed and administered by the thinkers and scholars and teachers within her own walls. "Elsewhere throughout the world," says an editorial in *Popular Science Monthly,* "the university is a republic of scholars administered by them—here it is a business corporation." In America the university is governed and unfortunately sometimes actually administered by men whose "life activities lie outside the realm they rule." "The very idea of a university as the home of independent scholars," says Professor Creighton, of Cornell, "has been obscured by the present system." "The disastrous effect of the system," says Professor Jastrow, of the University of Wisconsin, "is blighting the university career." "It is one of the most productive of the several causes," says Professor Ladd, of Yale, "which are working together to bring about the degradation of the professorial office." "If the proper status of the faculties is to be restored, if the proper standard of educational efficiency is to be regained, there must be," declares Professor Stevenson, "a radical change in the relation of the teaching and corporate boards." Says Mr. Munroe, of The Massachusetts Institute: "Unless American college teachers can be assured that they are no longer to be looked upon as mere employees paid to do the bidding of men who, however courteous or however eminent, have not the faculty's professional knowledge of the complicated problems of education, our universities will suffer increasingly from a dearth of strong men, and teaching will remain outside the pale of the really learned professions. The problem is not one of wages; for no university can become rich enough to buy the independence of any man who is really worth purchasing. Young men of power and ambition scorn what should be reckoned the noblest profession, not because that profession condemns them to poverty, but because it dooms them to a sort of servitude." "Whatever organizations may be necessary in a modern university," declared President Schurman, of Cornell, "the institution will not permanently succeed unless the faculty as a group of independent personalities practically control its operations."

These protests are made not merely by sore-headed, dyspeptic men whose principal business in life it is to growl and snarl, but by sober-minded, patriotic men, some of them the great scholars and thinkers of the nation. My own experience as a college executive confirms the opinion that the university career is becoming more and more repulsive to men of real ability. More and more also, our brightest students are turning from the teaching profession to enter the more independent and the more lucrative professions of law, of engineering, of medicine, of farming and of business. More and more students of mediocre ability, the wooden fellows without initiative or courage, are they who, subsisting upon scholarships and fellowships, turn towards the university career and work for the higher degrees. To become a Ph.D. appears to be the sole ambition of large numbers of them who, when the degree is won, seem satisfied to rest upon their laurels throughout the

remaining years of their lives. Of course rare and splendid exceptions there are, but more and more are able young men scorning the teaching profession as fit only for women and effeminate men. It has been humorously said that in the schools of the future, yea even in the universities, real men teachers will not be found except here and there a stuffed specimen in the university museum.

"Professor A," said the president of one of the best southern universities, "is a weak man."

"Of course he is," replied a well-known professor, himself a teacher of thirty years experience. "The very fact that he is a university professor is proof positive that he's a weak man. Nobody but a weak man or a blank fool would be a university professor."

In all earnestness, I may assert that during the past ten years I have talked frankly and sometimes confidentially with scores of able professors concerning the university career, and among them all I have found few men of real ability who have not felt more or less dissatisfied with the profession of teaching. "I love teaching and the work of the investigator," said a distinguished university professor only a few days ago, "but I feel so helpless and so dependent and so much like an hireling in the position I now hold, that I sometimes long to get out of the whole business."

There is something wrong somewhere if conditions such as are depicted even approximately exist. To change these conditions, to make the university an attractive place for great scholars and brave thinkers and lofty souls, and not, as it sometimes is, a stronghold for the politician, the timeserver, the coward, the sycophant—that is a work worthy of heroes and statesmen and educators. Big endowments for universities are desirable if not indeed necessary, but big brave men in universities are equally desirable and far more necessary. Only the greatest men of the nation are great enough to teach and inspire the young men of the nation. That nation is greatest which has in proportion to its population the greatest number of real universities, and that university is greatest which gathers to it the largest number of great men. Your really big professor would rather exist on a pittance in a university where he feels free and independent, master of his own soul, than to live luxuriously in a splendidly endowed school, dependent upon the good will or the caprices of politicians and ward bosses, or shivering in fear of offending some multi-millionaire upon whose bounty his university exists.

What, then, is the matter with the university? Scores of able men, whom I much admire, would lay foul hands upon the university president as though he were the cause of our academic slavery. They denounce him as an autocrat and a tyrant who, having seized every prerogative that he did not find nailed down, "holds a Damascus blade over other men's lives, careers, reputations." They would see the "presidential office shorn of its unwise and unsafe authority," of its "limelight conspicuousness," of the "foolish and increasing pomp and circumstance" which usually and increasingly attend presidential installations and, in vulgar eyes, transform wire pullers and gumshoe educators into great men and commanding figures upon the educational horizon. They would reduce his salary to that of an ordinary professor, have him live in a house not bigger nor better than the houses of his colleagues. Indeed there are in our universities able men and otherwise lovely souls to whom the very sight of a university president seems to be, if one may judge them by their words, like the waving of a

red flag to an enraged beast. To them the university president is "the black beast in the academic jungle." They cut him to pieces with their ridicule, they lash him with their wit, they make him ridiculous with a humor that seems inexhaustible.

"I once incited," says the distinguished editor of *Popular Science Monthly* and of SCIENCE, Professor Cattell, of Columbia University,—"I once incited one of my children to call her doll Mr. President, on the esoteric ground that he would lie in any position in which he was placed." The time of the university president, he tells us, is "largely occupied with trying to correct or to explain the mistakes he has made, and the time of the professor is too much taken up with trying to dissuade the president from doing unwise things or in making the best of them after they have been done."

Now, to be perfectly fair to Professor Cattell, it must be admitted that his hatred of university presidents is not against them as men, who, he admits, may be as truthful, honest and kind as the rest of the faculty, but against them as the products of a system that is calculated to produce sycophants, and bosses, and liars. It is doubtless true that some men, possibly many, have become college presidents not because of their merit, but because they are skillful politicians or successful wire-pullers, and it is also true that such men, when once they get into office, usually employ the methods of politicians and bosses. Such men build up a machine, gather around them a body of time-servers loyal to the administration, who also help to create for the real scholars of the university a chilling and forbidding atmosphere. Such presidents soon drive from their universities all the independent and high-spirited professors who can find places in other institutions and make miserable the lives of such professors as are too old to get away or are too ill-starred to find elsewhere an opening suited to their talents and attainments. Professor Cattell is doing a real service in pouring upon such men the contempt and ridicule they deserve. Such executives, whether they are found as principals of normal schools, superintendents of city systems, college heads or university presidents, deserve to be hung for high treason against the great republic of letters and the commonwealth of science. But let us not forget that they are the creatures, not the creators of a system that threatens, unless reformed, to turn over the temples of learning to educational gamblers and money changers, to bosses and politicians, to all the foul and loathsome creatures who, while "cowering to those above them always trample on those beneath them"—I mean the system that places in the hands of an external, irresponsible board the power to govern and to control in minutest details a great seat of learning.

Before I proceed further let me declare as emphatically as may be that the vast majority of trustees whom I have known I esteem as generous and upright men. It is the system, not the individuals that I am attacking. I wish that Professor Cattell could be induced to turn his vast learning to the consideration of this more fundamental question, and to let his illuminating wit play upon it—the question of the governing board of a university. May we not hope that President Pritchett of the Carnegie Foundation may get one of the really great educators of the world, or perhaps a committee of such educators, to write an authoritative bulletin on the functions and the limitations of the governing board, and place it in the hands of every school trustee in the land. This and other good literature bearing on the same subject

should be read by every university regent—indeed before taking oath of office he should perhaps be required to pass, before a committee of the faculty, an examination on the functions and limitations of a governing board. Such a bulletin, if widely read and studied by the great mass of thoughtful people, would do more for the cause of university education than the gift of millions to endowments. Indeed it may be confidently affirmed that the greatest single problem that concerns the American university is the problem of securing competent administrators.

The chief function of a university board is to resign if they find themselves incompetent or unable to do the work entrusted to them. If, however, they consider themselves competent, they should see to it, when vacancies occur, that they be filled by men intelligent enough and high-minded enough and patriotic enough to govern wisely a higher educational institution. Without a board composed of such men, the best endowed private university or the best supported state university is sooner or later likely to become, not a nursery of scholars and scientists and noble spirits, but a stronghold and a retreat of scheming, wire-pulling, snarling, backbiting, cringing, crawling, fawning pinheads and mediocrities and sycophants, bent on cutting the throats and destroying the reputation, of all who stand in their way—men who bear without whining the sting of the lash of their superior officers while administering still more heroic treatment to their own underlings.

The first essential qualification, both of a president and of a professor, is that he be a man, a brave, generous, high-minded man, and the first article in the creed of every real man is that, on the one hand, no matter how great the prizes to be won, he shall not cower to those above him, and, on the other, no matter what power may be placed in his hands, he shall not trample on those beneath him. Are our holy temples of learning to become a nursery of such men or are they to be transformed into what DeQuincey unjustly called the German universities, kennels of curs? It depends upon the governing board and upon the governing board alone.

It is true that back of the governing boards in state universities are the people who create the boards, or, as has happened in more than one state of the union, the people who create the bosses who create the governors who create the boards. In the strictest sense the people in a democracy are the sources of power and upon the people, in the last analysis, must fall whatever of glory or of shame is connected with their university administration. But since it is not possible to hold a whole people responsible we must turn to the men they intrust with authority, the trustees.

What limitation shall be placed upon the governing board? Almost none whatever if it be a good board. As in good colleges no rules whatever governing conduct are imposed upon students except the single injunction that they be gentlemen, so in the ideal university the question of the limitations of the faculty, the president, the board, may scarcely arise because all work for common good. A good board is not necessarily composed of great scholars, of millionaires, of merchant princes, of brilliant statesmen, of mighty potentates in church or state. A board composed of such men would not necessarily be a good board—it might be. A good board like a good tree will bring forth good fruit, and a bad board bad fruit. A good board will not abuse its power. Since, however, under existing conditions bad boards may creep into control, it may be advisable to put limitations upon them. As in monarchies

where bad kings once had unlimited power to inflict injustice and to disturb the lives of men, the people for protection have so hedged him about as to make him almost a figure-head, so it may become necessary in our great universities to put such limitations upon the governing boards that it will not be possible at least for them to do much harm, if indeed they are not wise enough or intelligent enough to do much good.

What, then, is a good board? A good board is composed of a body of men, whether large or small, who have at least two qualifications: (1) plain, old-fashioned honesty and horse sense; (2) technical knowledge, whether acquired in or out of the university, sufficient to call to their service competent experts, and to sift the advice of these experts and, when this is done and only then, to inaugurate right movements and wise policies, and to reach conclusions in the solution of the delicate and difficult problems that continually face such a board. The besetting sin of the university board is that they either do not know how, or, knowing how, are too cowardly, to call to their service the best educational experts. Hopeless beyond any possibility of redemption, the board that does not know that while they may govern, they can not administer, the university. That belongs to the faculty and to the faculty alone. How many American colleges and universities have been injured, if not indeed absolutely ruined, by meddlesome interference on the part of trustees with the work of the faculties, by the taking upon themselves tasks for which they are wholly unfitted, tasks that belong to the faculty. Sad indeed the state of that university whose board removes able professors who have rendered long service, to make places for men not fitted for professorial chairs or, worse still, for political henchmen without either the character or the training that fits them to become instructors of youth.

Many illustrations are at hand. Just before leaving home I had a letter from a well-trained teacher, which, as nearly as I can remember, reads as follows: "I am seeking a position in another school for the same reason that induces forty of our professors and three heads of our state institutions to look for positions elsewhere." In that state politicians on the board and off the board have so long tinkered with the state institutions and so long harassed the professors in them, that good men can endure it no longer except under the compulsion of stern necessity.

Take another illustration. Only a few weeks ago an old friend wrote me as follows: "For God's sake help me if you can. For years I have been harassed to distraction by this ignorant, conceited, crooked board. I am not merely on the brink, I am in the very middle, of hell itself." That man is an educator, an M.A. and a Ph.D. of a great American university.

Take another. Not long ago the president of a well-known state university said to me that he had decided to resign his position, giving as his reason the constant interference of the board in matters that seemed to him to belong to the faculty. He pointed out many instances of this interference. One member of the board, a lawyer and a college graduate, one day tossed before him a big bundle of papers with the remark: "The faculty has been giving a good deal of time to courses of study. I have taken up the matter myself. The other day I went down to my office, took off my coat and worked for four hours preparing a curriculum for each department of the university. Here it is and I expect you to put it through."

"Our colleges," says J. J. Chapman, an

unusually brilliant writer, "have been handled by men whose ideals were as remote from scholarship as the ideals of the New York theater managers are remote from poetry. In the meantime the scholars have been dumb and reticent."

One more illustration. "It falls just beyond my experience," says Professor Jastrow, of the University of Wisconsin, "to have members of the faculty addressed by a member of the board as 'you men whom we hire.' It is within my experience to have professors summoned inquisitorially before a committee of the board to give an account of themselves, the interview conducted by the chairman with his feet on the table, and displaying a salivary agility that needs no further description." Such reminiscences, however, as Professor Jastrow well says, carry no sting. They are merely amusing. Such men are apt to be good fellows, or at any rate, open-minded.

It is really amazing how dependent our universities seem to be upon the legal fraternity. I am making no brief against lawyers—the best board member I have ever known was a lawyer, but he was a big one, a great jurist, a profound scholar—but lawyers as a class are usually the worst men on boards because they love to split hairs, whereas big business men are the best because they are accustomed to do big things.

But to return. What state university president has not encountered some young lawyer, perhaps an alumnus, who has felt it his duty to inaugurate university reform and to match his ignorance of university matters against the combined wisdom of a score of learned professors who have given the best years of their lives to educational problems? It would be a humorous, if indeed it were not so often a tragic, spectacle. As well might we call the mediocre lawyer of a country village to revise the decisions of the Supreme Court and to tell the members of that august body how to transact the nation's business.

What president of long experience has not encountered the nouveau riche, the parvenu who, regarding the impecunious college professors as mere hirelings,' as mere dirt and rubbish, undertakes to establish policies to prevent rise of salaries and thereby to place the institution upon a sound financial basis. Sometimes, though rarely, one encounters the business man who, feeling how successfully he had conducted his department store or factory, begins at once to apply factory methods to the delicate and intricate, the high and holy work of a great educational institution. He also regards the teachers as hirelings. Is it any wonder that when university professors find themselves placed in humiliating subjection to men of this stamp they become unhappy, dissatisfied, disgusted even with the university career?

Then there is the small demagogue content with any old job that pays his traveling expenses and gives him an allowance of five dollars a day. He is not necessarily vicious, but only needy. Presidents have had worse men to deal with. A box of cigars, a good dinner, a bag of peanuts, or even a generous slap on the shoulder, may hold in check for a whole day his mighty, all-consuming passion for reform.

But there is another type of men sometimes found on university boards which I can not adequately describe because of the limitations of the English tongue and the refinement and culture of my audience. He is the pinhead. While great men become modest when vested with vast power or supreme authority, the pinhead, although he may be honest, although he will neither lie nor steal, is apt to become the very oracle of wisdom as

soon as he finds himself settled for life on a self-perpetuating board. Low-browed, thick-headed, sometimes the holder of a college degree, now strutting like a peacock, now looking wise as the owl, an indomitable fighter, he baffles the genius and the ingenuity of the ablest executive. The intelligent ward boss or the politician of big dimensions, no matter how crooked, is not quite so bad a man on a university board as the miserable little pinhead who is to me what the president is to Professor Cattell, "the veritable black beast in the academic jungle." No logic, no array of facts, no appeal to educational experts can make the slightest impression upon his small, thick skull. He is firm as adamant, vindictive as the viper, and in constant communion with the Almighty God. When thrown into conflict with such a man there is nothing for the president to do but to hold up his hands and to pray without ceasing that the Giver of all good things may bountifully bestow upon him the saving sense of humor, without which even the ablest university president must find the academic world a cold and cheerless place.

The road that leads out of these deplorable conditions is perhaps a long and rocky road, but we must find it and make our way out to a freer air, a happier environment, or else the very life of the university as an acropolis of culture, as the stronghold of the "great and lonely thinker," as the nursery of noble and heroic souls, is absolutely doomed. University boards can not longer afford to ignore the faculties. In all large questions of university administration, the faculty should have a hearing and a voice. To give to the faculties the control that belongs to them, to create both for students and professors a happier environment, is, after all, the high duty of administrators. I have an abiding faith in the outcome. To all brave souls who are growing weary and faint-hearted, let me commend the words of Carlyle: "It is our duty to do the work that God Almighty has entrusted to us, to stand up and fight for it to the last breath of our lives."

The work of establishing and administering a university calls for the united efforts of faculty and board and alumni, who should work together in mutual trust and esteem for the uprearing of a real university, the most potent instrument that man has yet devised for his own advancement, for the enrichment of his life, for the development and diffusion of knowledge, and for "the enlargement of the boundaries of the human empire to the attainment of all things possible."

Edwin Boone Craighead

INDIAN REMAINS IN MAINE

Early this year, the archeology department of Phillips Academy at Andover sent an expedition to the state of Maine to carry on an exploration of various sites. By the end of August the party had located and mapped some hundred or more shell-heaps and village sites. Forty-eight shell-heaps were found within ten miles of Bar Harbor, and if the circle be extended to fifteen miles, there must be at least 75. Several of these were examined and some hundreds of bone and stone implements taken therefrom.

The coast from below Blue Hill to Bar Harbor (excepting the Castine region) was carefully investigated in the hopes that a "Red Paint People" cemetery might be discovered. But in spite of much searching, no undisturbed site could be located, although disturbed cemeteries were found at Blue Hill and Sullivan Falls and about one hundred stone objects removed therefrom.

The largest shell-heap lay upon Boynton's Point in the town of La Moine. This deposit is more than 200 meters long and 20 to 30 meters in width. It is roughly estimated that

some 7,000,000 clam-shells are in the heap. About 300 articles in bone and stone were taken out of the trenches.

The harpoons collected by the expedition number some 40 or more and are interesting in that they present several types of hafting and barbing. Sections of the shells (in situ) were removed and shipped to Andover in order that a cross section may be exhibited. This will give visitors and students a better idea of the shell-heaps than the usual exhibits of articles removed from such places.

The expedition will end its labors about September 15. Dr. Charles Peabody directed the work, with W. K. Moorehead as curator in charge through the season. Francis Manning, of Harvard, was assistant and Ernest Sugden surveyor. The party numbered twelve or fourteen persons and the work done was extensive.

BONAPARTE RESEARCH FUND GRANTS[1]

The committee of the Paris Academy of Sciences appointed to consider the distribution of the Bonaparte research fund has made the following recommendations for the year 1913: H. Caillol, 3,000 francs, for the completion of his work entitled "Catalogue des coléoptères de Provence"; A. Colson, 2,000 francs, to enable him to continue his experimental work in physical chemistry; E. Coquidé, 2,000 francs, to assist him in carrying out his study of the turf lands of the north of France from the agricultural point of view; C. Schlegel, 2,000 francs, to enable him to continue his researches on Crustacean development; Jules Welsch, 2,000 francs to assist him in his geological exploration of the coast lines of France and Great Britain, and to extend them to Belgium and Scandinavia; MM. Pitard and Pallary, 6,000 francs, equally divided, for their scientific expedition in Morocco, organized by the Société de Géographie; Louis Roule, 2,000 francs, for the continuation and extension of his researches on the morphology and biology of the salmon in France; M. Pougnet, 2,000 francs, to enable him to continue his researches on the chemical and biological effects of the ultra-violet rays, and for the construction of a quartz apparatus to be used for studying the action of ultra-violet light upon gaseous bodies; M. Dauzère, 2,000 francs, for his work on the cellular vortices of Bénard; M. Gard, 2,000 francs, for the publication of a work and atlas dealing with the material left by the late M. Bornet; M. Chevalier, 4,000 francs, to meet the expenses necessitated by the classification of the botanical material collected in the course of his travels in western and equatorial Africa, and the publication of memoirs on the flora of these regions; Paul Becquerel, 2,000 francs, for the continuation of his physiological researches relating to the influence of radioactive substances on the nutrition, reproduction and variation of some plant species; Le Morvan, 4,000 francs, for the completion of his photographic atlas of the moon; M. Pellegrin, 2,000 francs, to aid him in the pursuit of his researches and to publish his work on African fishes, more particularly those of the French colonies; M. Rengade, 3,000 francs, for his proposed systematic examination of mineral waters for the presence and distribution of the rare alkaline metals; M. Alluaud, 3,000 francs, for facilitating the study and publication of documents collected by M. Jeannel and himself on the alpine flora and fauna of the high mountainous regions of eastern Africa; M. Lormand, 2,000 francs, for the purchase of a sufficient quantity of radium bromide to undertake methodical researches on the action of radioactivity on the development of plants; A. Labbé, 2,000 francs, for the study of the modifications presented by various animals passing from fresh to salt water or the reverse; de Gironcourt, 3,000 francs, for the publication of the results of his scientific expeditions in Morocco and western Africa; M. Legendre, 3,000 francs, to assist him in the publication of the maps and documents dealing with his travels in China; H. Abraham, 2,000 francs, for the determination, with Commandant Ferrie and M. A. Dufour, of the velocity of propagation of the Hertzian waves between Paris and Toulon.

[1] From *Nature*.

SCIENTIFIC NOTES AND NEWS

In honor of Professor John Milne and to continue his work in seismology, it is proposed to collect a fund for endowment. His seismological observatory will probably be moved from the Isle of Wight to Oxford.

The Hanbury medal of the Pharmaceutical Society will be presented to Dr. F. B. Power, director of the Wellcome Research Laboratories, London, on the occasion of the opening of the School of Pharmacy in October, when Dr. Power will give the inaugural address.

Dr. Richard P. Strong, professor of tropical diseases in the Harvard Medical School; Dr. Ernest E. Tyzzer, assistant professor of pathology and director of cancer research at Harvard, and Dr. C. T. Brues, of the Bussey Institution, have returned from the expedition, on which they started on April 30, to study tropical diseases in Peru and Ecuador.

Professor von Noorden has resigned his chair in the University of Vienna and will return to Frankfort.

The council of the University of Leeds has accepted with regret the resignation of Mr. Roberts Beaumont, professor of textile industries, and has placed on record its appreciation of his services lasting over a period of thirty-four years.

Dr. J. L. Prevost has retired from the chair of physiology at Geneva on reaching the limit of age.

Dr. Louise Pearce, of the staff of the Johns Hopkins Hospital, has been appointed assistant to Dr. Simon Flexner, of the Rockefeller Institute for Medical Research. Dr. Franz Knoop, associate professor of physiological chemistry at Freiburg, has declined a call to the institute.

The Glasgow City Corporation has arranged to send on a tour to this country Mr. W. W. Lachie, the engineer of the electricity department, together with the convener of the electricity committee, for the purpose of collecting information regarding the cost and operation of the largest electrical installations of this country.

Dr. Mario Piacenza, the Italian botanist, has succeeded in reaching the summit of Mount Numzkum, a peak 22,000 feet high in the Himalayas.

The death is announced, in his fifty-first year, of Professor Edwin Goldmann, honorary professor of surgery at Freiburg.

Dr. C. M. Figueira, long professor of clinical medicine of Lisbon, and one of the few scientific men of Portugal, has died at the age of eighty-four years.

Dr. Carl Basch, of Prague, known for his work in physiology, has died at the age of fifty-four years.

The forty-first annual meeting of the American Public Health Association will be held in Colorado Springs, Colo., from September 9 to 13, under the presidency of Dr. Rudolph Hering, of New York. The work of the association has been divided into the following sections: Laboratory Section, Professor F. P. Gorham, of Providence, R. I., chairman, and Dr. D. L. Harris, of St. Louis, secretary; Section in Vital Statistics, Dr. W. S. Rankin, of Raleigh, N. C., chairman, and Mr. David S. South, of Trenton, N. J., secretary; Section of Public Health Officials, Dr. P. M. Hall, of Minneapolis, chairman, and Dr. E. C. Levy, of Richmond, Va., secretary; Section in Sanitary Engineering, Colonel J. L. Ludlow, of Winston-Salem, chairman, and Dr. H. D. Pease, of New York, secretary; Sociological Section, Mr. Homer Folks, of New York, chairman, and Mr. S. Poulterer Morris, of Denver, secretary.

The international committee, which met in Paris recently to decide upon the place and time of the next meeting of the International Eugenics Congress, has decided to accept the invitation to hold the next congress in New York in 1915, on or about September 20. The American delegates to the recent congress were Dr. Frederick Adams Woods and Dr. David Starr Jordan. The arrangements for organizing the next congress rest with the American delegates and the Eugenics Record office at Cold Spring Harbor, N. Y.

THE exhibition of specimens illustrating the modification of the structure of animals in relation to flight which has been in preparation for many months at the Natural History Museum has, as we learn from *Nature,* been opened to the public. It occupies the fourth bay on the right of the central hall, and comprises 166 mounted objects and twelve microscopic specimens for the purpose of elucidating the subject in a popular manner. The adaptation of each kind of flying animal for aerial locomotion is explained, and the changes that must have taken place in the struture of the body before the animal could really fly are indicated, and attention is directed to the remarkable fact that the power of flight has been evolved independently in different groups of animals—*e. g.,* bats, birds, Pterodactyles and insects.

DR. HENRY GODDARD LEACH, secretary of the American-Scandinavian Foundation, has returned from an official tour of Sweden, Norway and Denmark. The foundation was endowed by the late Niels Poulson, president of the Brooklyn Iron Company, with $600,000 to maintain an interchange of students, teachers and lecturers, and to promote in other ways intellectual relations between this country and Scandinavia. Fellowships have been awarded to two representatives from each of the three countries, and they will enter universities in this country this fall. Plans also have been discussed for an exchange of professors between the University of Copenhagen, the University of Christiania, the University of Upsala and several American institutions. Dr. Leach left New York in May to confer with the advisory committees of the three Scandinavian countries concerning the choice of fellows, who will pursue their studies here. One of those chosen is Ellen Gleditsch, from Norway, who has studied for five years with Mme. Curie in Paris, and will take up her work here in Johns Hopkins University. Her countryman, Arnt Jacobsen, is a student of bridge construction. Denmark is represented by C. M. Pederson, a student of technology, who will enter the Massachusetts Institute of Technology, and Vilhelm Slomann, a student of library methods, who will go to the State Library in Albany. Sweden will send Erik Koersner, a civil engineer, and Einar Corvin, an investigator in experimental psychology.

ACCORDING to a cablegram from New Zealand to the daily papers, relief arrived just in time to save Dr. Douglas Mawson, the Australian Antarctic explorer, and his five companions who were left last March on Macquarie Island in the Antarctic Ocean when the remaining twenty-four members of Dr. Mawson's expedition returned to Tasmania from their South Polar trip. The six men were believed to have ample provisions to last them until the Antarctic spring, but the commander of the government steamer recently sent to their relief reports that the explorers had exhausted all their supplies. Two members of the Mawson expedition—Lieutenant Ninnis, an English army officer, and Dr. Xavier Mertz, a Swiss scientific man, lost their lives in accidents on the ice. The original expedition left Hobart, Tasmania, on December 2, 1911, its principal object being the exploration and survey of the Antarctic coast line. When the *Aurora* went to fetch the explorers back, early this year, the vessel was forced to leave before taking on Dr. Mawson and five of his companions forming one of the parties, as the ship was in danger of being crushed by the ice.

A CONFERENCE on the Binet-Simon tests was arranged by Professor Lewis M. Terman, of Stanford University, to be held at Buffalo on August 29 in connection with the Fourth International Congress of School Hygiene. The special purpose of the conference is to consider matters relating to needed revisions of the scale and to its proper use. The following papers were in the program:

Dr. Henry H. Goddard: "The Reliability of the Binet-Simon Scale."

Dr. Otto Bobertag, of the University of Breslau: "Some Theses regarding the Scientific Management of the Binet Scale."

Dr. F. Kuhlmann: "The Degree of Mental Deficiency in Children as expressed by the Relation of Age to Mental Age."

Professor Josiah Morse: "The Use of the Binet Tests in the Investigation of Racial Heredity."

Professor W. H. Pyle: "The Value to be Derived from giving Intelligence Tests to all School Children."

Dr. Charles Scott Berry: "Some Limitations of the Binet Tests of Intelligence."

Dr. Carrie R. Squire: "Some Requirements of Graded Mental Tests."

Dr. Grace M. Fernald: "Impressions gained by the Use of the Binet-Simon Tests with Delinquent Children."

Dr. E. A. Doll: "Suggestions on the Extension of the Binet Scale."

Professor J. E. W. Wallin: "Current Misconceptions in Regard to the Functions of Binet Testing and of Amateur Psychological Testers."

Professor Lewis M. Terman: "Revisions of the Binet Scale."

Professor G. M. Whipple: Title of paper to be announced.

THE 67th report of the British Commissioners in Lunacy, as abstracted in the London *Times*, states that the number of notified insane persons under care in England and Wales on January 1, 1913, was 138,377, an increase during the year of 2,716, which is 275 above that of the annual average of the last ten years and 257 above that for the last five years. The private patients under care on January 1, 1913, numbered 11,353 (males, 4,852; females, 6,501). The pauper patients were 125,841 (males, 58,508; females, 67,333), or 90.9 per cent. of all the reported insane. The criminal patients numbered 1,183 (males, 903; females, 280). Since 1898 numerical record has been kept of the first admissions. In that year they were at the rate of 4.92 per 10,000 of the population, and in 1912 the figure was 5.12, a higher figure than obtained in either of the three preceding years, but below the average rate (5.2) during the last decade. The proportion which such cases bore to the total admissions in the last year was 83.5 per cent., which implies that, for every 100 admitted, between 16 and 17 had been previously under care—a proportion which is rather below the average. On January 1, 1912, there were under detention 108,973 persons, and 22,432 were admitted during the year, making a total of 131,405. Of these 7,345 were discharged as "recovered," 2,182 were discharged as "not recovered," 10,353 died and 111,525 remained. On the subject of treatment the commissioners say it would seem to be needful to turn from the therapeutic side to the preventive, if insanity is to be effectively controlled; or rather that, whilst retaining and improving the former class of measures, more ample consideration should be given to the latter. The condition precedent for this is a fuller knowledge of causation to be gained by the prosecution of scientific research.

THE exhibited collection of Mesozoic crocodiles in the geological department of the British Museum (Natural History) has been rearranged, as we learn from *Nature*, to incorporate some important recent acquisitions. A new specimen of *Mystriosaurus* from the Upper Lias of Würtemberg, prepared by Mr. B. Hauff, is one of the finest known examples, with almost complete limbs. The stomach contents are seen, mingled with swallowed pebbles. A specimen of *Geosaurus*, from the Lithographic Stone of Bavaria, shows for the first time the triangular tail-fin by which this essentially marine crocodile propelled itself. The unique example of the Wealden river crocodile *Goniopholis*, discovered a few years ago by Mr. R. W. Hooley in the cliff near Atherfield, Isle of Wight, and described by him in the Geological Society's *Journal*, has also been mounted and exhibited.

UNIVERSITY AND EDUCATIONAL NEWS

THE sum of $71,000, being all but $5,000 of the estate of the late Dean Mary Coes of Radcliffe College, is left to the college.

ALTHOUGH the buildings which comprise the complete group of the new Manitoba Agricultural College, that will cost $5,000,000, will not be completed for two or three years, sufficient progress has been made to allow the college to commence moving equipment into the buildings already completed. The site on the bend of the Red River, a few miles south of Winnipeg, contains 1,100 acres.

THE Mobile City Hospital is being enlarged by a new building containing four wards, at a cost of $50,000. It will give accommodation to eighty additional patients, as well as provide suitable quarters for the out-patient de-

partment, new X-ray laboratory, pathological rooms, etc. Medical control of the hospital is entirely in the hands of the faculty of the School of Medicine of the University of Alabama.

At a recent meeting of the New Mexico Board of Medical Examiners a rule was adopted that hereafter diplomas granted by colleges listed in class C by the Council on Medical Education of the American Medical Association will not be recognized by that board.

Under the law of Missouri, the State University receives an inheritance tax of five per cent. on all legacies, except those to direct heirs. The university has brought suit to recover this percentage on the part of Joseph Pullitzer's estate represented by the *St. Louis Despatch* and bequeathed to Columbia University and other institutions.

Elmer A. Holbrook, professor of mining engineering in the Nova Scotia Technical College, Halifax, Nova Scotia, has been appointed assistant professor of mining engineering at the University of Illinois, to have charge of the recently equipped coal-washing and ore-dressing laboratory and the course in mine design.

Professor Lewis E. Young, who for the past six years has been director of the Missouri School of Mines, will in September take up graduate work in the department of economics at the University of Illinois, and will also give part of his time to teaching in the department of mining engineering.

Dr. W. C. McC. Lewis, having been appointed to the chair of physical chemistry in the University of Liverpool, has resigned his office in connection with the department of chemistry at University College, London.

Dr. Otto Wilckens, associate professor of geology at Jena, has been called to Strassburg, to succeed Professor Holzapfel.

DISCUSSION AND CORRESPONDENCE

AGRICULTURAL EXTENSION

In the June, 1912, number of the *Experiment Station Record* (Vol. XXVI., No. 8) is an editorial dealing with several methods for disseminating agricultural information. An exceedingly interesting part of this editorial is the review of a paper on "Organization and Administration of Extension Teaching in Agriculture" by the director of the federal Office of Experiment Stations.

The writer need hardly assume to write any critical review of statements made by Director True. In view, however, of conditions which exist in various places throughout the country, it may be proper to say that certain statements made by Director True ought not only to be read, but also reread, because they are fundamental. Properly adopted and made part of our educational systems, they will make for progress and avoid not only confusion, but ofttimes unnecessary strife. These fundamental principles for agricultural extension in the several states which seem to be stated in the editorial referred to, are as follows:

> 1. Considered as an essential feature of the American system of agricultural education, it was held to be primarily the business of the state to create and maintain the institutions through which extension teaching in agriculture shall be conducted. Since it is an educational enterprise, it will naturally be carried on by educational institutions rather than by administrative departments. The nation and state departments of agriculture may both properly aid in this work, but the chief burden of responsibility for it in the several states will naturally fall on the agricultural colleges.
>
> 2. Since it is highly important that the information on any subject given to the students and public should represent the views of the institution as a whole, all the experimenters, teachers and extension workers should be grouped by departments representing the specialties in which they are working. Thus the department of agronomy should embrace all the agronomists employed by the college, whether they are engaged in experimenting, teaching or extension work.

These two basic principles, namely, that *it is a function of the state to educate the people of the state* and that *given lines of work in any organization must be administered as a unit,* ought to be clear enough. However, a somewhat limited observation would lead one

to believe that one or both of them are forgotten in some instances and that the forgetting of them leads to little short of disaster.

The writer is interested in the problem of agricultural extension, not in an executive, but in a departmental way. It is this interest which every department, and every member of every department, must take in the ultimate success of the projects which the department represents, that may serve as an excuse, if any be needed, for the present article.

The writer knows, or thinks he knows, from observation, that the practical administration of the agricultural extension idea may be, on the one hand, exceedingly helpful, or, on the other, quite disastrous to any department. In order that harmony of administration shall prevail, "the department of agronomy should embrace all the agronomists employed by the college, whether they are engaged in experimenting, teaching or extension work." The quotation may of course be extended to include all departments of any agricultural college. Every department of every agricultural college should have a head or chief, and he should be responsible for all the work and all the time of all people in the college-experiment-station-extension department who are engaged in the line of work which he represents.

Such a statement may sound dictatorial. It is not. It is only good administration.

So great a movement upon the part of the collective agricultural colleges as the one necessitated by the present demand for public-service or "extension" is bound to carry them back, or perhaps forward, to fundamentals. What is the logic of college "departments"? Answer, college departments logically grow out of natural lines of cleavage between the several portions of work before the college organization. Such lines of cleavage do not naturally intersect, and if they are permitted or forced to do so, the result is confusion. The lines of distinction between the natural departments of agricultural work are clear enough. Animal husbandry, agronomy, horticulture and so on can hardly trespass upon the work of one another, because each division of work grows out of fundamental differences. If the natural divisions of labor, as a result of which departments are created, are kept very clearly in mind by organizations, in "extending" their work, the problem appears not very complex.

Such a statement naturally leads to the inference that the several departments of the college are sovereign within themselves, except for the general executive authority which emanates from the office of the dean or president, and as a corollary it would be expected that all representatives of a given line of work should at all times report directly to the chief of the department and not, for instance, directly to the director of extension. That is also exactly so. "No man can serve two masters: for either he will hate the one, and love the other, or else he will hold to the one and despise the other."

In what relation, then, is agricultural extension in the several agricultural colleges to be administered? In attempting to answer the question, the writer makes bold, very bold, perhaps, to insert the following plan of an ideal administrative arrangement of the departments of an agricultural-college-experiment-station organization.

It may be apparent from this ideal arrangement that the office of the dean and director is the central administrative authority of the entire college. In case of the smaller colleges where the dean assumes the title of president, there is no essential difference. The dean and director not only administers the institution, but he reflects the spirit of the institution. He represents the state in which his college is located in the specialty which his college represents. He is big enough and broad enough and sympathetic enough and democratic enough to provide ways through which all the departments of his organization may independently each attain its highest efficiency. The efficiency of the executive office is not only measured by the efficiency of the several departments which report to it, but also by the ability of the dean and director to transform such efficiency and make it available to the state.

Obviously the departments of any agricultural-college-experiment-station organization are divided according to the work to be specialized in by each department. Obviously also the number of departments will vary according to the financial resources of the institution and the degree of specialization. The number of departments will usually increase as the institution grows older and stronger.

The work of each department shall be directed by the head of that department and he shall accomplish, through the aid of assistants of various ranks, all the work within the field of the department. Assistants in any department may be of any desired rank, and it may well be understood that they are subordinate to the head of the department only as a matter of administrative convenience.

Up to recent times, two distinct lines of work have been recognized as coming within the function of agricultural colleges, namely, research and teaching. Moreover, up to recent times, the teaching in the agricultural colleges has been confined mainly to ordinary instruction in college classes. Of late years it is becoming more and more evident that this is not sufficient. It is not necessary here to review the various means by which the teaching work of the colleges is being and must be carried beyond the classrooms proper.

It is necessary to emphasize that wherever this extension teaching is carried, it must still be teaching, and that it differs only somewhat in place and method from any other teaching. Whether it is classroom teaching or extension teaching is absolutely the same so far as administration is concerned. The same departments which do one kind of teaching must finish their duty. The same departments which do research work and carry the results into the classroom by the process of teaching, must finish their duty and carry the results along with other accumulated data directly to the state at large. Whether a department shall disseminate information by having students come to its classrooms or whether it shall extend itself by going to the four corners of the state, does not change the department, except perhaps in number of assistants and specialists who will be necessary to accomplish the increased work.

If all this be true, what is the logical relation of the extension department and what is the need therefor?

The later-day call for extension "departments" in agricultural colleges has grown out of the insistent demand that the agricultural colleges shall actually serve the state. Extension departments are, therefore, evidences of our growing democracy, crude and ungainly as that may often seem.

Logically, the extension department of any college includes all movements, inaugurated by the dean and director, to extend the work of his organization into the state. The dean and director may be his own extension man, that is, he may personally direct the work of disseminating information from his institution. If due to lack of time or inclination, he extends the work of his institution through the medium of a superintendent of extension, the case is not altered. The superintendent or secretary of extension, if there be one, must logically function as an assistant to the dean and director.

The authority of the superintendent of extension is whatever authority is given him by the dean of the college, whose assistant he is. He should have no power to usurp the authority of any of the heads of departments, nor does he have control over any of the work or any of the time of assistants in any of the departments, for if he has such authority, he will be a general nuisance around all departments, which means around the entire institution and the entire state. If he is strong enough in personality, he will disrupt the entire organization.

The logical work of the superintendent of extension is to assist the dean in collecting and disseminating agricultural information. His usefulness in the institution will be measured by his ability to do this to the fullest extent harmoniously. In detail, his work would naturally include such matters as the arrangement of meetings throughout his state, and to secure speakers from the college to

attend these meetings. In order to arrange for these speakers, he must of necessity confer with the heads of the several departments and have them delegate one or more of their assistants to do such work at specified times. It will be expected that the heads of departments will delegate such speakers unless it is absolutely impossible to do so on account of lack of help. If any given department is constantly unable to furnish teachers for extension work, either a lack of ability or a lack of desire upon the part of the department is indicated and the department should either have more assistance to strengthen it or it should be otherwise helped by executive action. Thus the superintendent of extension shall have a very strong moral influence delegated to him by the dean and director in persuading departments to do every reasonable amount of extension work, but he should not have any absolute authority to go into a department and disorganize it.

By this same token, the superintendent of extension should be an arm of the executive office and not a department head.

There should be no department of college extension in the same sense as there are other departments based upon natural division of labor. The function of extension is to extend the work of collective departments and not in itself to be a department. If it is allowed to be a department, it can only do so by either duplicating a part of the essential work of other departments or by usurping the same, and again it becomes a private and public nuisance.

There are colleges of agriculture in the United States, which if named would at once be recognized as in many respects the strongest in all the country in which the superintendent of college extension is virtually an assistant to the dean and not head of a coordinate department. Two of these greatest agricultural colleges which the writer has in mind have offices of college extension that are seldom talked about, but the colleges themselves are talked about and the work they do in their respective states is also talked about. The writer can think of other colleges where there are separate departments of college extension. The college-extension departments are very much talked about. The colleges they are supposed to represent are not so much talked about.

As time goes on the personnel of departments and their assistants and executives and all understand that they are servants of democracy. When that time, which is rapidly approaching, is completely here, no college or experiment station will rest content without putting its useful and usable information as rapidly as possible into the hands and hearts and heads of the people where it belongs. This latter work may be accomplished in the doing by an office of agricultural extension, but said office will not function like an extraneous department pasted on over other departments like a porous plaster.

A. N. Hume

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A NEW ATTACHMENT FOR THE HARVARD KYMOGRAPHION

Certain methods have been used for studying the effect of fatigue on the muscle curve. Among these there is the old method of recording a make or break contraction; this method consists of removing the writing point from the drum and stimulating the muscle a certain number of times, say nine. The drum is revolved a few millimeters with the hand, then the writing point is replaced against the drum. This is repeated regularly at every tenth contraction until the muscle ceases to respond. This gives a series of straight lines on the drum formed by every tenth contraction of the muscle. The height of these lines gradually decreases as fatigue comes on until the zero point is reached; but it does not tell of the important changes occurring in the latent period and the period of relaxation.

This has been overcome on those particular types of European and American kymographions which have the supporting frame for the drum external. On these types of machines an insulated copper wire may be led

direct from the dry cell and wound around the rod or arm supporting the top of the drum, bent so that the short, bare, free end is directed downward. Now a second copper wire may be led from the opposite pole of the cell to the simple key and connections made from it with other wires via the inductorium to some basilar portion of the instrument. Next, a clean copper wire may be twisted or clamped to some part of the top of the revolving drum and properly adjusted in such a way that, if contact is just barely made with the first wire the circuit will be completed for an instant and the desired stimulus to the muscle will be given at certain definite intervals, always at exactly the same time on a uniform moving drum. In other words, the circuit is through the instrument and its action becomes automatic. In the case of the Harvard kymographion such an arrangement can not be used, for inasmuch as the drum is held by a spring to the sleeve which in turn fits over a tall vertical rod with its base resting on the friction plate there is no external support of the drum for attaching the wires.

Accordingly, in order to produce such automatic action on this particular type of machine, it is evident that some other device must be used. The one which has been worked out by the writer has been very successfully used at the laboratory of the University of Maryland during the past year. It consists of a thin metal disk of about 18 mm. diameter with a central opening large enough to admit the screw of the spin-screw and is held in place by means of the spin-nut against the head of the sleeve of the kymographion. To the outer under edge of this disk are soldered four copper wires of two thirds mm. diameter and about four cm. in length, which radiate out horizontally from the flat under surface of the disk and revolve with the drum. The circuit is then made complete by leading wires of two thirds mm. diameter; one series from the cell, first to the simple key and inductorium. then to the milled head, or some other basilar portion of the instrument; and the other to a tall iron-stand where the insulated wire may be wound around the upper portion of the upright rod, in order to hold it in place with about 6 or 7 cm. of the free end projecting laterally from it and vertical to the rod. Just enough of the insulation is removed from the far end of the wire to make a small eye about 3 mm. in length and 2 mm. in width, and bent so that the loop is directed downward. Into this is placed a wire pendulum made from the same kind of wire (uninsulated) having a similar sized eye at one end and being 5 to 6 mm. in length. When properly adjusted this wire arm projects out over the top of the drum of the kymographion, so that the wire pendulum just barely touches the outer extremities of the radiating arms as they come from the disk and revolve with the drum, thus making the electrical contact for just an instant, and thereby stimulating the muscle automatically.

It is of the utmost importance that the eye in the end of the wire and also the pendulum and ends of the radiating wires from the disk be kept clean and bright by means of emory paper, so that the electrical contact may always be at its highest point of efficiency. I might also mention the fact, that, if the pendulum is allowed to drag itself over the radiating arms by being too long, it will usually have a bouncing movement making several contacts and giving as many stimuli to the muscle.

It is also of advantage, although not absolutely necessary, to use a second simple key between the wire containing the pendulum and the cell, so that the circuit may be broken without stopping the instrument, or moving it away. However, one simple key in the circuit is usually sufficient.

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ACCURACY IN STATING THE OCCURRENCE OF SPECIES

To the Editor of Science: The difficulties of exact scientific expression pointed out by Mr. J. D. Kusen[1] relate to the loose use of certain words in attempting to describe the

[1] Science, Vol. XXXV., June 14, 1912, pp. 930, 931.

comparative abundance or rarity of certain species of birds in a given locality, at a given time. There are two methods of meeting this difficulty, neither of which will probably meet the approval of every one. The former of these, which will be outlined later, has grown into general use and with a reasonable exercise of common sense in judging the relative occurrences of the species, with due regard to season, meets most requirements.

The latter method will dispense with the sometimes indiscriminate and loose use of adjectives and adverbs such as "very rare," "rather common," etc., and the substitution of a system suggested, I believe some decades ago, by the late Joshua Billings. This system under proper use and a full study of any given locality will express, with mathematical accuracy, all gradations of the occurrence of any species, not only of birds but of the entire range of the vegetable and animal kingdoms.

In this system, the absolute zero and maximum occurrence of any species would be represented by exact expressions indicating accurately the abundance or rarity of a given species. The scales of abundance and rarity would cross or intersect at the gradation now vaguely expressed by the word "common," and their use would entirely dispense with any doubt as to its meaning, and also with such expressions as "very common," "not uncommon," "rather rare" and the like. Mr. Billings's system would express the superlative of abundance, like blackbirds in a tree in spring or the hairs on a dog's back, by *abundance 100;* grading down numerically to *abundance 0,* which would cover the case of no blackbirds at all or the degree of hairiness presented by a billiard ball. *Rarity 0* would express the entire absence of a given species, while *rarity 100* would express an approach to abundance which need not necessarily be noted in the terms of the rarity scale at all.

It will be noted at once that abundance 50 = rarity 50, and that any degree of accuracy can be secured by the decimal system thus:

Myiarchus Crinetus, abundance 67.3; or *Vireo Philadelphicus,* rarity 2.7. An obvious advantage of this system is that it will cultivate close and systematic study coupled with accuracy in the expression of results, but they are both subject to serious interruptions by the habits of migration and breeding which vary the occurrence of all species to such an extent as to necessitate commencing the work over again before it could be satisfactorily completed. This, however, is not without its advantages, particularly if those who undertake to alter or direct the use and development of our language by juggling with its synonymous terms could be set at putting the system in use. But for the great mass of English-speaking scientists in search of the clearest mode of describing the things they see and of setting forth the thoughts they have, good Anglo-Saxon well understood and properly used is a strong and flexible medium.

Marsden Manson

San Francisco, Cal.

"QUITE A FEW"

To the Editor of Science: I have just read with much interest the illuminating paper by Professor H. L. Bolley, of the North Dakota Agricultural College, in Science of July 11, with the caption "The Complexity of the Microorganic Population of the Soil."

The writer is however somewhat puzzled to know just what is meant by an expression used by Professor Bolley, in its relation to the commonly accepted standard of what is called "good English." The expression referred to is "quite a few," introduced in the following sentence: "So now, there seems to be quite a few who think they can tell a productive soil," etc.

The puzzle is, to apprehend just what Professor Bolley means by "quite a few." We can well understand that the expression "a few" means a very small number of units; and in the formula "quite a few" there would seem to be an emphasis placed on the "few" by the qualifying adverb "quite." So that in an analysis of the formula the conclusion must be that "quite a few" means a less number of units than "a few."

Is that the idea that Professor Bolley intended to convey, that the number of persons referred to by him in this connection is less than "a few"? Or does he mean more than "a few"; or exactly as many as "a few"?

This array of logical discussion is of course mere quibbling, and is designed to bring out the writer's surprise, that a learned teacher, in a scientific disquisition in a scientific journal, should have introduced this slangy and meaningless expression, that has appeared of late years as a malevolent fungus growth on our "mother tongue," and become a sort of fad much affected by the "light weights" of our present social and literary world.

With apologies to all concerned.

T. G. Dabney

Clarksdale, Miss.,
July 17, 1913

SCIENTIFIC BOOKS

The Fitness of the Environment. An Inquiry into the Biological Significance of the Properties of Matter. By Lawrence J. Henderson, Assistant Professor of Biological Chemistry in Harvard University. New York, The Macmillan Company. 1913.

This book is essentially a discussion of the nature and implications of organic adaptation, *i. e.*, of the relations between the living organism and the environment, but is written from an unusual point of view.

Darwinian fitness is compounded of a mutual relationship between the organism and the environment. Of this, fitness of environment is quite as essential a component as the fitness which arises in the process of organic evolution; and in fundamental characteristics the actual environment is the fittest possible abode of life. Such is the thesis which the present volume seeks to establish.

This quotation from the preface defines clearly the author's general purpose and indicates broadly the general nature of his treatment. In his discussion he inverts the order of procedure customary with biologists. Adaptation, he points out, is a reciprocal relation, depending quite as much on the existence of special conditions in the environment as in the organism. This environment—nature, or the physical cosmos—exhibits in its ultimate constitution certain characteristics which are of such a kind as to favor the production and continued or stable existence of living systems or organisms. The world, in other words, is, and was from the beginning, fitted for the abode of life. This was the contention of Paley and the other natural theologians. It implies a biocentric conception of nature—a conception once familiar and, indeed, historically the first to be formed, but which has fallen into disrepute since the rise of the theory of evolution. Dr. Henderson aims at rehabilitating this view and supporting it by an appeal to the results of modern physical science. His conception of nature has thus some of the characteristics of Paleyism in a modernized form, but is essentially uncolored by theological and philosophical prepossessions. The greater part of the book is devoted to an account of the chief physico-chemical peculiarities of the environment. This is largely a description of the general properties of matter, with especial regard to their biological fitness. Attention is called to many conditions favorable to the production and continued existence of living beings. Carbon, hydrogen and oxygen, the most abundant and widely distributed of the elements, and their chief compounds, particularly water and carbon dioxide, possess a variety of properties and modes of behavior which render them ideally adapted to the formation of systems having the characteristics that we call vital. What is insisted on as remarkable is not merely the existence—in such a substance as water—of single properties that are biologically favorable; it is the possession of a unique *combination* of characteristics shown by no other substance, and which so far as we can see could not possibly be possessed by any other substance, that gives water its unique fitness as a component of living matter. Similarly, with carbon dioxide and the other chief compounds of carbon with hydrogen and oxygen: they are uniquely favorable as constituents of protoplasm and no substitutes are conceivable.

In support of these contentions, the author proceeds as follows: He first reviews

the distinguishing characteristics of the living organism. All organisms are primarily complex, *i. e.,* the number of distinguishable structural and functional components is large; they are the seat of continued chemical change involving constant interchange of matter and energy with the environment—in a word, of metabolism; and they exhibit durability or stability in an environment more or less subject to change; in other words, the possession of an automatic power of adjustment to changing conditions, or of *regulation,* is typically highly developed. Complexity, regulation and an energy-yielding metabolism are thus essential to organisms. The question is then asked: "To what extent do the characteristics of matter and energy and the cosmic processes favor the existence of mechanisms which must be complex, highly regulated, and provided with suitable matter and energy as food?"

By a process of elimination the author defines water and carbon dioxide as those constituents of the environment which are most essential to life. The physico-chemical peculiarities of these two substances are then considered at length. The remarkable solvent, thermal and dielectric properties of water are shown to be indispensable to the complexity and stability of living protoplasm; the importance of its chemical properties, especially its ionizing and hydrolyzing action, is also dwelt upon. Similarly, the many remarkable properties of carbon dioxide are pointed out, in particular, its high solubility—a necessary condition for enabling organisms to utilize it in such large quantity—and its dissociation-constant, which has just the value that is most favorable to the preservation of an approximate neutrality in aqueous solutions containing its salts: protoplasm is thus protected against wide variation in its hydrogen-ion concentration; the constancy of reaction thus secured is a highly important factor in securing constancy of chemical conditions in cells, and hence in furnishing the conditions for a stable chemical organization. Other important constituents of the environment are salts: the abundance and variety of these in sea-water are pointed out, and their importance in vital processes—depending largely on their characteristic relations to the colloids—is emphasized. Water, carbon dioxide and salts are thus the essential constituents of the environment of living organisms, and it is ultimately from these substances that the living matter is synthesized. In correspondence with the importance assigned to these substances, special chapters are devoted to water, carbon dioxide and the ocean. The properties of substances in a state of solution are also discussed (osmotic pressure, diffusion, ionization). The following chapter reviews the chief features in the chemical behavior of the three chief elements and their compounds. The author insists that carbon alone, of all the elements, has the properties which render possible the formation of compounds sufficient in number, kind and complexity for vital processes. He also calls especial attention to the *mobility* of carbon—due to the gaseous nature and high solubility of its oxide—and to the importance of the high heat combustion of carbon and hydrogen and their compounds in the energetics of vital processes. By simple reduction, followed by polymerization, carbonic acid passes over into the sugars; and thus the first step from the simple gaseous oxide to complex organic substances, which at the same time are reservoirs of energy, is remarkably simple and direct. The close chemical affiliations of the sugars to many other compounds important to the organism are also briefly discussed. This part of the book is itself a concise summary and hence can not be satisfactorily summarized. The author's essential conclusion is that the foregoing characteristics of carbon, hydrogen and oxygen, which make possible the production of living protoplasm, constitute a series of maxima—are unique when compared with the corresponding properties of other elements. Hence they show the greatest possible fitness for life.

In Chapter 7 the argument is restated in more concise form, and in the final chapter, "Life and the Cosmos," the possible significance of living beings in the whole scheme of nature is considered. How comes it that the

unique properties of carbon, hydrogen and oxygen should be so favorable to the organic mechanism? should fit the universe for life? Are cosmic and biological evolution one? Is there a teleology inherent in nature? There follows a brief discussion of vitalism. The views of Driesch and Bergson, which postulate a physical indeterminism in the organism—*i. e.*, maintain that guiding or activating factors other than physico-chemical intervene in life —are rejected. There is no evidence of gaps in the organic nexus. Yet the possibility of a vitalistic point of view, which is nevertheless consistent with a belief in the entire adequacy of physico-chemical analysis, is not thus excluded, and the author insists that this possibility must be recognized. Cosmic and biological evolution *may* be one. There remains as consistent and possible a teleological view, not of life alone, but of the whole cosmos and thus of life considered as a part or product of the cosmic process. The universe may after all be biocentric. It is not to be expected that scientific research will ever find any instances of complete discontinuity or indeterminism in nature, as the eloquent paragraph quoted from Royce rightly insists; all single events are rigidly determined; but the existence and characteristics of the natural process as a totality, including life as one outcome of this process, are not to be accounted for by purely scientific methods of explanation. A teleological and, by implication, a vitalistic interpretation of nature thus becomes possible. The philosophical questions thus raised are not, however, discussed in detail.

Such is an outline of this interesting, clearly written and thoughtful book. The author's style shows precision and definiteness throughout, and his treatment is clear and consecutive. The account of physico-chemical factors and processes is modern and accurate.[1] In so condensed a book it is easy to point out omissions. More space might well have been devoted to a consideration of the rôle of nitrogen in organisms; this element is fully as important as carbon, hydrogen or oxygen. The chapter on organic chemistry is probably too concise to be popularly intelligible. The section on sugars is perhaps over-technical and its concluding paragraphs are not very clearly expressed. Little space is given to proteins. The difficulties of popular presentation become almost insuperable here, and the author seems to hurry over this part of the task.

It remains to consider critically the general argument of the book. The author transfers the conception of fitness from the organism to the inorganic environment in order to emphasize the reciprocal character of biological adaptation. He then devotes almost his entire space to showing that the environment possesses characteristics favorable to life as we find it. Having shown this, he omits considering in corresponding detail the characteristics of the organism itself, and the general nature of the inter-relations between organisms and environment—in other words, what adaptation itself is, as a general condition or process; and this method of treatment gives a certain impression of incompleteness. Now it is quite clear that the universe must show itself, on examination, to be a fit environment for living beings, since they continue to exist in it; further, this fitness must show itself maximal in the case of organisms showing maximal adaptation to their surroundings; and thus the general outcome of the author's argument might have been foreseen. Granted that systems having the properties of living beings could not have arisen had the properties of carbon, hydrogen and oxygen, and of their combinations, been other than they are, what does this prove? Most biologists will probably consider the author's central thesis as either self-evident or inherently unprovable,[2] and will prefer to regard this book as essentially a scientific essay on the biological importance of the more general and

[1] On page 177 osmotic pressure is said to be proportional to the total number of particles (molecules *plus* ions) which are present in solution, instead of in unit volume of solution, but such inadvertencies are rare.

[2] That is, this world may be the best possible environment for the organisms that have come to exist in it, but it might not be so for the living beings of another and quite different cosmos!

elementary properties of the elements and compounds entering into the formation of protoplasm. Considered in this light alone, the book is remarkable for the breadth and ingenuity of its treatment and for calling attention to many facts and principles the importance of which is often overlooked. To many readers this will constitute its chief interest.

This, however, is not exactly the reviewer's opinion. The question of the final significance of biological adaptations is raised in a novel and interesting form, and some further discussion of this question seems called for here. What, after all, is meant by this conception of adaptation? Considered from the most general point of view, it seems best to regard adaptation as essentially an instance of *equilibrium,* though of a complex kind.[3] Equilibrium is a conception of physical science, and as such susceptible of exact definition; to regard adaptation in this light implies that the problems which it presents are essentially physiological in their nature, and hence relegates the teleological point of view to the background. This is always advantageous for physical science, however it may be for practical life or philosophy. To many, the statement that adaptation is an equilibrium may seem either metaphorical or a truism; to the physiologist it embodies a definite conception of the organism as a physico-chemical system which maintains its existence by a continued succession of automatic compensations. What we observe is that the adult organism preserves its characteristics intact, for a greater or less period of time, in spite of continual loss of material and energy to the environment. Now, the processes by which this loss is balanced by a corresponding intake, thus enabling the life-processes to continue, are just those which we characterize as "adaptive." The structural and functional adjustments necessary to maintain this balance are often delicate and complex in the higher organisms; they involve the existence of special mechanisms—such as the hand, the eye and many others; but these always correspond to certain constant features of the environment, and play a part which in the last analysis is essentially compensatory in the above sense. To put the matter in somewhat different and more general terms: if the characteristics of a system undergoing perpetual change of composition and loss of energy are to be maintained constant, it is indispensable that a set of processes antagonistic to and therefore compensatory to these changes should be maintained. The adaptive and regulatory, and most of the "purposive" activities of an organism form the conditions necessary to the existence of these compensatory processes. Evidently, this point of view implies a fitness in the environment as well as in the organism. The two must correspond as lock to key—or as the oppositely directed and mutually equilibrating components of *any* system in equilibrium—if any such interaction is to be possible. Hence the continued existence of any organism implies environmental fitness, *i. e.,* the existence of conditions and processes in the environment which correspond to or balance those in the organism. It is thus inevitable, if we consider the special peculiarities of any complex and stable system, and correlate them with those of the environment, that the latter should be found to exhibit a "point for point" and reciprocal correspondence with the former. The case of the organism has seemed exceptional simply because biological students have been so long accustomed to regard the organism as a system possessing unique "vital" properties and existing in an environment having totally distinct characteristics. To the human mind there is no more profound contrast than that between living and lifeless. Dr. Henderson's study shows that even in its ultimate constitution the environment possesses characters corresponding to those of the living organism, and the discovery of this truth will no doubt surprise many others, just as it surprised him. But what if this were not the case? Obviously, such systems as organisms could never have come into existence. The surviving organic forms are simply

[3] Adaptation is treated from this point of view in Paul Jensen's "Organische Zweckmässigkeit, Entwicklung und Vererbung vom Standpunkte der Physiologie," Jena, 1907.

those which can maintain an equilibrium with their environment. Of course conditions may arise which disturb this equilibrium. If, then, the organism possesses insufficient power of compensating these new conditions, it sooner or later ceases to exist. Natural selection is simply the process by which such imperfectly compensated living systems are eliminated. The conception of a selective agency as operative in this process of adapting organisms to environment is frankly anthropomorphic, and hence from the standpoint of physical science insufficiently exact. It is better to replace it by a conception in which the organism is regarded as a material system maintaining a dynamic equilibrium[4] with the environment. That the environment should have the character of fitness—that its processes should equilibrate those of the organism—is not surprising, is indeed self-evident. One chief aim of biological science, in fact, is to show how the characteristics of the organism are related to, and ultimately proceed from, those of the environment.

The task of biological science is thus left where we found it. To account for the characteristics of organisms on the basis of the physico-chemical characteristics of their component elements and compounds involves showing how the characters of living beings are derived from those of the environment. To do this in detail would involve retracing the course of evolution. Obviously, this can be done only in outline; but a necessary presupposition of any such undertaking is that the chemical elements which form the inorganic cosmos possessed from the beginning of organic evolution such a constitution and such modes of interaction as to render possible the production of living beings. By some thinkers this statement may be understood to imply that life was implicit or potential in the universe from the very first. But to the scientific investigator such a statement can have little meaning, since it is remote from the possibility of verification. He might even regard it as one more of the many useless and distracting freaks of verbalism. In point of fact, the course of scientific inquiry is little affected by such considerations.

From another point of view, however, such a statement ceases to be a truism, and acquires significance as one form of the philosophical insistence on the essentially unitary nature of the cosmos. The problem of vitalism is then seen in a clearer light. On the interpretation of natural science the evolutionary process can have followed only one course. Just why evolution has followed the course leading to the present outcome is a problem for philosophy rather than for science. Most scientific men agree that natural science aims at describing phenomena and tracing their interconnections, and does not try to account for the existence of nature itself. Now the problem of the place of living beings in nature has both its scientific and its philosophical aspects. The biological vitalists have tried to account for the physico-chemically unanalyzed pecularities of organisms by assuming the existence of special extra-physical vital agencies (entelechies and the like). Dr. Henderson's discussion of this problem regards all such solutions as inadmissible. Since we can not separate living beings from their environment, it is clear that organisms must, from the scientific point of view, be considered and investigated in the same manner as the environment, *i. e.*, as the rest of nature. The vitalism of Driesch and Bergson is thus discountenanced, and insistence is made on the adequacy of the physico-chemical methods of investigating life-phenomena. The author believes that the only possible form of vitalism is one which regards the entire cosmic process as in its essence and from its inception biocentric in character. This is obviously a philosophical rather than a scientific point of view, but it has the advantage of interfering in no way with a scientific consideration of life or of any other natural process; and in the reviewer's opinion also it is the only tenable form which vitalism can assume. It is difficult to see how scientific exception can be taken to such a doctrine. It has, in fact, been held

[4] Equilibrium of processes, and not simply of static conditions, *e. g.*, a whirlpool, candle-flame, etc.

by various philosophers, though hitherto by relatively few scientific men.

It is evident on closer consideration that the existence and peculiarities of organisms must become completely unintelligible *except* on the assumption of a rigid and unvarying uniformity in the essential character of the processes taking place in living matter. The existence of material systems of such extreme complexity, which nevertheless maintain a stable existence and act in a manner which is uniform and within limits predictable—so that each human individual has a definite personal character—is in fact the most convincing proof that could be asked of the uniformity and invariability, as regards both their nature and their interconnections, of the innumerable substances, conditions and processes underlying the vital manifestations. Not only is the assumption of an extra-physical entelechy unnecessary, but it renders more difficult instead of easier the task of biological analysis, since it introduces a factor whose operation is *ex hypothesi* inconstant and unpredictable, and hence incompatible with the stability that vital conditions require. The assertion of Bergson that the living organism is characterized by a maximum of indeterminism[8] makes the organic mechanism completely unintelligible, and to a physiologist seems almost the precise inverse of the truth. It is evident that in any physiological process any even momentary variation or deviation from a constant physico-chemical mode of action—say any inconstancy in the law of mass-action—would derange the whole interdependent system of processes, and render continued life impossible. The organism constitutes in fact the most impressive illustration that nature offers of the unfailing constancy of natural processes. The course of embryonic development is as essentially constant a process as the revolution of the moon about the earth, besides being far more complex; and this stability of the organic processes is fully as necessary to the continued existence of the species as is that of the inorganic processes. The usual forms of vitalism are hence inherently unintelligible and self-contradictory. It is certain that the advance of physical science, and especially of biological science, offers no escape from the deterministic dilemma. Experience shows everywhere not only interconnection between phenomena, but an invariability in the modes of interconnection. Constant repetition always exhibits itself as the order of nature, when the elementary constituents and processes are observed. The question inevitably arises: how then is it possible to reconcile teleology and the existence of will and purpose in nature with the existence of a physico-chemical determinism which appears the more rigid the further scientific analysis proceeds? Such problems are usually left on one side by scientific men, and this is not the place for their fuller discussion. Obviously, however, they require biological knowledge for their solution—if, indeed, they are ever to be solved; and one chief merit of the book under review is that it directs the attention of biologists once more to the importance and urgency of these questions.

[8] "Creative Evolution," Chapter 2.

Ralph S. Lillie

The Interpretation of Dreams. By Sigmund Freud. Authorized translation of third edition by A. A. Brill. New York, The Macmillan Co. 1913. Pp. xii + 510. Price $4.

The "Interpretation of Dreams" is one chapter in Freud's theory of the neuroses, and was arrived at by the same methods which proved so useful in the study of the latter. This study revealed principles of even wider application than the sphere from which they were derived, and led to the author's illuminating psychopathology of every-day life. Similarly the dreams of normal people have become much more intelligible in the light of the analysis of psycho-neurotic symptoms and of the dreams of psycho-neurotic patients. Those who are familiar at first hand with the mechanisms of the neuroses and who are at home in the literature of the subject will find the "Interpretation of Dreams" an extremely stimulating monographic treatment of one aspect of a very large subject. To those who

are not at home in the realm of the neuroses, and who take up this book in the atmosphere of the study or the experimental laboratory and would try to correlate it with the psychological data with which they usually work, the book is apt to be startling, unconvincing, repellent. The latter would have no difficulty in finding easy openings for criticism, both as regards method and form of presentation. The criticisms which have been brought forward against Freud's whole theory of the neuroses will no doubt be brought up in relation to this book, to the effect that it is largely a question of assumptions, ingenious but far-fetched hypotheses, and unconvincing arguments lacking proof. As to what proof actually consists in hostile critics are apt to be discreetly silent. It must be remembered that the type of demonstration appropriate to one topic may be quite out of place in relation to another; the satisfactory proof of a paleontological thesis is something very different from a mathematical demonstration. The proof that a certain piece of flint is really an arrow-head and not a mere casual product of nature consists in showing its place in a large series, and the extent of that series, which the individual requires in order to be convinced, will largely depend upon the attitude of the individual. So the extent of the series of data required to convince a reader of the truth of certain principles as to the neuroses and dream interpretation will depend very largely on certain personal factors. The presentation of material must necessarily be comparatively limited and much depends on what the reader can himself supply to supplement the data of the book; if he should have no relevant data at his command then the whole theory of dream interpretation may seem highly artificial. Any one with wide experience must admit the essential truth of certain general principles, while reserving judgment on the conclusiveness of certain detailed interpretations.

The method employed by the author in the interpretation of the dream is that of free association, a method which he found useful in his psycho-analytic work. After the first chapter, which deals with the literature on dreams, Freud presents us an example of his method of interpretation of a dream, and in the succeeding chapters he defends his thesis that the dream is essentially the fulfilment of a wish: "The dream is the (disguised) fulfilment of a (suppressed, repressed) wish." The term wish must not be taken in too crude a manner, but is used to represent a variety of vague strivings and longings which are dynamic factors that frequently escape the notice of clear consciousness. The author demonstrates conclusively that dreams frequently represent wishes in an undisguised form, and that they often represent wishes in a more or less distorted manner. But he goes further; he maintains that the dream *always* represents the fulfilment of a wish. In two examples which the author quotes, the fact that the dream represents the opposite of the fulfilment of a wish is interpreted as showing that the patients desired to prove that Freud was wrong in his theory of the nature of dreams. This is one example of the subtlety of the author's argument which never leaves him at a loss, but which, on the other hand, is more ingenious than convincing. The argument, too, would be more satisfactory if the patient who wished to refute Freud dreamed that she was dreaming. The fifth chapter (pp. 138 to 259) is devoted to an analysis of the actual stuff of which our dreams are made, and the sources from which the material comes. The important thing is that behind the trivial and absurd manifest dream content, thoughts of serious personal significance are always found at work. Memories of childhood experiences here play an enormously important rôle. In this connection Freud takes up the analysis of certain typical dreams and gives many examples of the symbolism which occurs in dreams. His statements are frequently dogmatic, *e. g.*, with regard to the meaning of dreams about landscapes and localities of familiar appearance (p. 242). On the other hand, Freud himself draws the line at some of the interpretations advanced by Stekel. His criticism of his pupil is not altogether inapplicable to his own product: "These interpretations

seem neither sufficiently verified nor of general validity, although the interpretation in individual cases can generally be recognized as probable." In the sixth chapter the author discusses the manner in which the stuff of our dreams is woven into the final tissue, and he describes in detail the four main processes, viz., condensation, displacement, dramatization, secondary elaboration. In the final chapter, the obscurity of which is somewhat increased in the translation, the psychology of the dream activities is discussed in a general way. For this purpose Freud constructs a scheme of psychological activity which is extremely interesting and suggestive, but which on the other hand is peculiarly artificial.

Since its publication in the first German edition this book has met with a very mixed reception. The bible of the author's disciples, it has been derided by his opponents. Any person who has had to deal seriously with the problems of the psycho-neuroses and of the disordered mind in general, and who has been impressed with the value of the psychopathological principles derived from Freud's contributions for the general development of psychological and allied studies, will look upon this book as a serious contribution to a most important field. The more knowledge he has of the actual facts the slower will he be in dogmatically rejecting even those statements of the author which are unconvincing and apparently rather extreme. He probably is already firmly convinced of the truth of many doctrines which at an earlier stage of his own work he looked upon as equally far-fetched and perhaps even more absurd.

C. Macfie Campbell

Tables Annuelles de Constants et Données Numériques de Chemie, de Physique et de Technologie. Published under the patronage of the International Association of Academies by the international committee named by the Seventh Congress of Applied Chemistry (London, June 2, 1909). Vol. I. for 1910. Gauthier-Villars, Paris, University of Chicago Press. 1911. Quarto. Pp. xxxix + 727.

This first volume of the annual tables and numerical constants, published under the auspices of an international committee representing twenty-one countries, shows the prodigious undertaking assumed by the committee. The list of collaborators comprises no less than thirty-one distinguished scientific authorities, and the number of abstractors of scientific journals about three times as many. The book is divided into forty-six chapters, and the table of contents covers eighteen pages in French, German, English and Italian.

The material is admirably arranged, and to every table are appended the name of the investigator and a reference to the original memoir. Thus, every item may be verified by consulting the original publication. Every scientific worker in the fields covered by this volume has in condensed form the results of allied investigations and information relative to the original sources. Moreover, the general secretary offers to assist in obtaining fuller information concerning memoirs in journals not accessible to the reader.

It is difficult to conceive of any compilation of scientific data better adapted to furnish information to the investigator in physics, chemistry and technology. A close inspection of the contents of this volume reveals a wealth of data and a variety of subjects that command not only respect but admiration. The investigator has in this book an invaluable adjunct to his reference library of scientific books and periodicals. It will broaden his view of the particular field of research in which he happens to be engaged, and will give him collateral information relative to many other allied subjects. The fulness of this information is indicated by the data relating to conductivity of electrolytes and electromotive forces, which cover forty-six large quarto pages. Under the first come specific conductivities, molecular conductivities, constants of electrolytic dissociation, transport numbers, coefficient of pressure of electrolytic conductivity, conductivity of electrolytes in solvents other than water, conduc-

tivity of electrolytes in a mixture of solvents, and conductivity of a mixture of electrolytes in pure solvents. The tables of electromotive forces include those of normal cells, of transition cells, of concentration cells, the potential of simple electrodes, and divers unclassified electromotive force effects.

In addition to the above there are forty-seven pages devoted to data in general electricity and magnetism. Immediately following these are eight pages on radioactivity and ionization. The writer finds nothing on the Peltier effect or on the important subject of electrolytic thermo-electromotive force.

A bibliography is appended to every main division of the book. An alphabetical index would add much to the convenience of reference. The second volume for 1911 contains both a general and a special alphabetical list of all substances mentioned in both volumes.

HENRY S. CARHART

SPECIAL ARTICLES

AN ILLUSTRATION OF THE INFLUENCE OF SUBSTRATUM HETEROGENEITY UPON EXPERIMENTAL RESULTS

IN experimental breeding so much stress has been laid upon controlled fertilization that some other factors of importance for the obtaining of trustworthy results have been left too much out of account. The importance of heterogeneity in the substratum upon which the plants are grown as a possible source of error has been pointed out time and again. De Vries, for example, attaches great weight to this factor.

The purpose of this note is to give point to these warnings (too greatly neglected now) by showing how extrinsic influences may completely screen intrinsic tendencies.

In very extensive series of materials a positive correlation has been demonstrated between the weight of the seed planted and the number of pods on the plant into which it develops—that is, yield is higher in the plants from the heavier seeds. This is true without exception for twenty series, involving 13,099 plants, already published.[1] Further constants based on 4,856 plants, are given below. Here the coefficient of correlation, r_{wp}, shows the relationship between the weight of the seed planted (in the conventional units of .025 gram range) and number of pods per plant, while the second term of the regression straight line equation,[2]

$$p = \left(\bar{p} - r_{wp}\frac{\sigma_p}{\sigma_w}\bar{w}\right) + r_{wp}\frac{\sigma_p}{\sigma_w}w,$$

shows the absolute change in number of pods per plant for each unit change in seed weight.

Series	Number of Plants	Coefficient of Correlation and Probable Error	Regression Straight Line Equation
GGH.......	583	$.208 \pm .027$	$p = 1.931 + .539w$
GGD.......	514	$.159 \pm .029$	$p = -3.504 + .361w$
GGDD.....	342	$.137 \pm .036$	$p = -1.967 + .279w$
GGHH....	396	$.194 \pm .033$	$p = -2.321 + .513w$
GGD_2......	449	$.215 \pm .030$	$p = -4.861 + .436w$
GGH_2......	499	$.176 \pm .029$	$p = -1.037 + .485w$
GG..........	750	$-.368 \pm .021$	$p = 17.418 - .403w$
LG..........	182	$.066 \pm .050$	$p = 2.351 + .134w$
LL...... ...	1141	$-.009 \pm .020$	$p = 7.245 - .012w$

The constants are in excellent agreement with those already published—fairly large and positive throughout—with the exception of the Golden Wax, the *L* series, and the *GG* culture of Burpee's Stringless. Those for the Golden Wax series, *LG* and *LL*, are sensibly zero; one is the smallest positive coefficient yet found while the other is negative in sign, though only a fraction of its probable error.

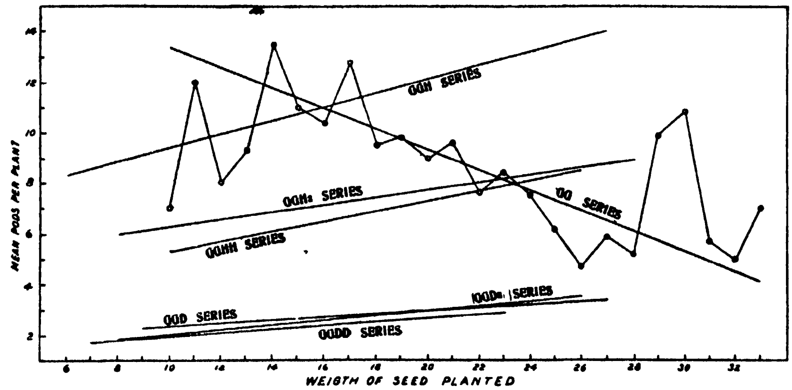
The coefficient for the *GG* series is in striking contrast to the others; not only is it numerically the largest value recorded, but it is negative in sign and unquestionably signif-

[1] Harris, J. Arthur, "The Relationship between the Weight of the Seed Planted and the Characteristics of the Plant Produced—I.," *Biometrika*, Vol. 9, pp. 11–21. See also *Amer. Breed. Mag.*, Vol. 3, pp. 293–295.

[2] p = pods per plant, w = weight of seed planted. The bars indicate the means and the sigmas denote the standard deviations of the characters in question. Through a slip in the copying of the manuscript which I overlooked in the proofs, the second term of the regression formula is given the negative sign on p. 14, *Biometrika*, Vol. 9. The values in the calculated equations are of course correct.

icant, being nearly eighteen times its probable error.

The comparison of the *GG* series with the other Burpee's Stringless cultures is forcibly brought out by the diagram. This shows the linear graduations (from the equations given in the table) of the number of pods per plant for various seed weight classes. Only the *GG* series, for which the empirical means are also shown,[3] indicates a decrease in the number of pods associated with an increase in the weight of the seeds planted.[4]



The explanation of this result is simple. In each of these 29 experiments with the exception of the *LL, LG* and *GG* series, the seeds were individually labelled, thoroughly shuffled and planted at random over the field to counteract the possible heterogeneity of the soil.[5] In the case of the *LL* and *LG* series I suspected that the soil conditions were not strictly uniform, but the various "pure lines" were planted in numerical order across the field, just as is usually done. In the *GG* series the weight groups were planted in order across a garden plot *which was selected for its apparent uniformity of soil.* This was again in accordance with ordinary experimental practise.

But many unknowable factors are involved in the productive capacity of the soil and it appears that the particular parcel of ground selected, although only large enough to grow 750 plants, changed in productiveness from one side to the other. By chance the seeds were so planted that the smaller ones were given the best conditions. So great was the heterogeneity that it not only neutralized the influence of seed weight which is always demonstrated when experiments are made with proper refinements,[6] but actually brought about a negative correlation between weight of seed planted and number of pods produced *which is numerically the highest found in twenty-nine cultures!* Had the order of planting been reversed, both soil fertility and seed weight would have been active in the same direction, and an abnormally high positive correlation would almost certainly have been the result.

J. Arthur Harris

Cold Spring Harbor, L. I.,

June 10, 1913

[3] The inclusion of all the empirical means would have rendered the graph too confusing. Graphic tests made for each case affords no evidence that a curve of a higher order would be better than a straight line.

[4] For the *GGD*, *GGD*$_2$ and *GGDD* series the slope of the line is very slight. This is due simply to the fact that these cultures were grown under much more adverse conditions than the others, and such wide variation in number of pods per plant is not possible.

[5] The importance of this procedure has been emphasized in *Amer. Nat.*, Vol. 45, pp. 697–698, 1911; Vol. 46, p. 325, 1912.

[6] The seeds used in the *GG* series were the ancestors of those employed in all the other experiments with Burpee's Stringless. Thus there can be no criticism because of "differences between the pure lines used."

SCIENCE

Friday, September 12, 1913

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE PLACE OF PURE MATHEMATICS[1]

It is not a very usual thing for the opening address of this section to be entrusted to one whose main energies have been devoted to what is called pure mathematics; but I value the opportunity in order to try to explain what, as I conceive it, the justification of the pure mathematician is. You will understand that in saying this I am putting myself in a position which belongs to me as little by vocation as by achievement, since it was my duty through many years to give instruction in all the subjects usually regarded as mathematical physics, and it is still my duty to be concerned with students in these subjects. But my experience is that the pure mathematician is apt to be regarded by his friends as a trifler and a visionary, and the consciousness of this becomes in time a paralyzing deadweight. I think that view is founded on want of knowledge.

Of course, it must be admitted that the mathematician, as such, has no part in those public endeavors that arise from the position of our empire in the world, nor in the efforts that must constantly be made for social adjustment at home. I wish to make this obvious remark. For surely the scientific man must give his time and his work in the faith of at least an intellectual harmony in things; and he must wish to know what to think of all that seems out of gear in the working of human relations. His

[1] Address of the president to the Mathematical and Physical Science Section of the British Association for the Advancement of Science, Birmingham, 1913.

own cup of contemplation is often golden; he marks that around him there is fierce fighting for cups that are earthen, and largely broken; and many there are that go thirsting. And, again, the mathematician is as sensitive as others to the marvel of each recurring springtime, when, year by year, our common mother seems to call us so loudly to consider how wonderful she is, and how dependent we are, and he is as curious as to the mysteries of the development of living things. He can draw inspiration for his own work, as he views the spectacle of a starry night, and sees

How the floor of heaven
Is thick inlaid with patines of bright gold.
Each orb, the smallest, in his motion, sings,

but the song, once so full of dread, how much it owes to the highest refinements of his craft, from at least the time of the Greek devotion to the theory of conic sections; how much, that is, to the harmony that is in the human soul. Yet the mathematician bears to the natural observer something of the relation which the laboratory botanist has come to bear to the field naturalist. Moreover, he is shut off from inquiries which stir the public imagination; when he looks back the ages over the history of his own subject the confidence of his friends who study heredity and teach eugenics arouses odd feelings in his mind; if he feels the fascination which comes of the importance of such inquiries, he is also prepared to hear that the subtlety of nature grows with our knowledge of her. Doubtless, too, he wishes he had some participation in the discovery of the laws of wireless telegraphy, or had something to say in regard to the improvement of internal-combustion engines or the stability of aeroplanes; it is little compensation to remember, though the mathematical physicist is his most tormenting critic, what those of his friends who have the physical instinct used to say on the probable development of these things, however well he may recall it.

But it is not logical to believe that they who are called visionary because of their devotion to creatures of the imagination can be unmoved by these things. Nor is it at all just to assume that they are less conscious than others of the practical importance of them, or less anxious that they should be vigorously prosecuted.

Why is it, then, that their systematic study is given to other things, and not of necessity, and in the first instance, to the theory of any of these concrete phenomena? This is the question I try to answer. I can only give my own impression, and doubtless the validity of an answer varies as the accumulation of data, made by experimenters and observers, which remains unutilized at any time.

The reason, then, is very much the same as that which may lead a man to abstain from piecemeal, indiscriminate charity in order to devote his attention and money to some well-thought-out scheme of reform which seems to have promise of real amelioration. One turns away from details and examples, because one thinks that there is promise of fundamental improvement of methods and principles. This is the *argumentum ad hominem*. But there is more than that. The improvement of general principles is arduous, and if undertaken only with a view to results may be ill-timed and disappointing. But as soon as we consciously give ourselves to the study of universal methods for their own sake another phenomenon appears. The mind responds, mastery of the relations of things, hitherto unsuspected, begin to appear on the mental horizon. I am well enough aware of the retort to which such a statement is open. But, I say, interpret the fact as you will, our intellectual pleasure in life cometh not by might nor by power—arises, that is,

most commonly, not of set purpose—but lies at the mercy of the response which the mind may make to the opportunities of its experience. When the response proves to be of permanent interest—and for how many centuries have mathematical questions been a fascination?—we do well to regard it. Let us compare another case which is, I think, essentially the same. It may be that early forms of what now is specifically called art arose with a view to applications: I do not know. But no one will deny that art, when once it has been conceived by us, is a worthy object of pursuit; we know by a long trial that we do wisely to yield ourselves to a love of beautiful things, and to the joy of making them. Well, pure mathematics, as such, *is* an art, a creative art. If its past triumphs of achievement fill us with wonder, its future scope for invention is exhaustless and open to all. It is also a science. For the mind of man is one: to scale the peaks it spreads before the explorer is to open ever new prospects of possibility for the formulation of laws of nature. Its resources have been tested by the experience of generations; to-day it lives and thrives and expands and wins the life-service of more workers than ever before.

This, at least, is what I wanted to say, and I have said it with the greatest brevity I could command. But may I dare attempt to carry you further? If this seems fanciful, what will you say to the setting in which I would wish to place this point of view? And yet I feel bound to try to indicate something more, which may be of wider appeal. I said a word at starting as to the relations of science to those many to whom the message of our advanced civilization is the necessity, above all things, of getting bread. Leaving this aside, I would make another reference. In our time old outlooks have very greatly changed; old hopes, disregarded perhaps because undoubted, have very largely lost their sanction, and given place to earnest questionings. Can any one who watches doubt that the courage to live is in some danger of being swallowed up in the anxiety to acquire? May it not be, then, that it is good for us to realize, and to confess, that the pursuit of things that are beautiful, and the achievement of intellectual things that bring the joy of overcoming, is at least as demonstrably justifiable as the many other things that fill the lives of men? May it not be that a wider recognition of this would be of some general advantage at present? Is it not even possible that to bear witness to this is one of the uses of the scientific spirit? Moreover, though the pursuit of truth be a noble aim, is it so new a profession; are we so sure that the ardor to set down all the facts without extenuation is, unassisted, so continuing a purpose? May science itself not be wise to confess to what is its own sustaining force?

Such, ladies and gentlemen, in crude, imperfect phrase, is the *apologia*. If it does not differ much from that which workers in other ways would make, it does, at least, try to represent truly one point of view, and it seems to me specially applicable to the case of pure mathematics. But you may ask: What, then, is this subject? What can it be about if it is not primarily directed to the discussion of the laws of natural phenomena? What kind of things are they that can occupy alone the thoughts of a lifetime? I propose now to attempt to answer this, most inadequately, by a bare recital of some of the broader issues of present interest—though this has difficulties, because the nineteenth century was of unexampled fertility in results and suggestions, and I must be as little technical as possible.

PRECISION OF DEFINITIONS

First, in regard to two matters which illustrate how we are forced by physical problems into abstract inquiries. It is a constantly recurring need of science to reconsider the exact implication of the terms employed; and as numbers and functions are inevitable in all measurement, the precise meaning of number, of continuity, of infinity, of limit, and so on, are fundamental questions; those who will receive the evidence can easily convince themselves that these notions have many pitfalls. Such an imperishable monument as Euclid's theory of ratio is a familiar sign that this has always been felt. The last century has witnessed a vigorous inquiry into these matters, and many of the results brought forward appear to be new; nor is the interest of the matter by any means exhausted. I may cite, as intelligible to all, such a fact as the construction of a function which is continuous at all points of a range, yet possesses no definite differential coefficient at any point. Are we sure that human nature is the only continuous variable in the concrete world, assuming it be continuous, which can possess such a vacillating character? Or I may refer to the more elementary fact that all the rational fractions, infinite in number, which lie in any given range, can be enclosed in intervals whose aggregate length is arbitrarily small. Thus we could take out of our life all the moments at which we can say that our age is a certain number of years, and days, and fractions of a day, and still have appreciably as long to live; this would be true, however often, to whatever exactness, we named our age, provided we were quick enough in naming it. Though the recurrence of these inquiries is part of a wider consideration of functions of complex variables, it has been associated also with the theory of those series which Fourier used so boldly, and so wickedly, for the conduction of heat. Like all discoverers, he took much for granted. Precisely how much is the problem. This problem has led to the precision of what is meant by a function of real variables, to the question of the uniform convergence of an infinite series, as you may see in early papers of Stokes, to new formulation of the conditions of integration and of the properties of multiple integrals, and so on. And it remains still incompletely solved.

CALCULUS OF VARIATIONS

Another case in which the suggestions of physics have caused grave disquiet to the mathematicians is the problem of the variation of a definite integral. No one is likely to underrate the grandeur of the aim of those who would deduce the whole physical history of the world from the single principle of least action. Every one must be interested in the theorem that a potential function, with a given value at the boundary of a volume, is such as to render a certain integral, representing, say, the energy, a minimum. But in that proportion one desires to be sure that the logical processes employed are free from objection. And, alas! to deal only with one of the earliest problems of the subject, though the finally sufficient conditions for a minimum of a simple integral seemed settled long ago, and could be applied, for example, to Newton's celebrated problem of the solid of least resistance, it has since been shown to be a general fact that such a problem can not have any definite solution at all. And, although the principle of Thomson and Dirichlet, which relates to the potential problem referred to, was expounded by Gauss, and accepted by Riemann, and remains to-day in our standard treatise on National Philosophy, there can be no doubt that, in the form in which it was originally

stated, it proves just nothing. Thus a new investigation has been necessary into the foundations of the principle. There is another problem, closely connected with this subject, to which I would allude: the stability of the solar system. For those who can make pronouncements in regard to this I have a feeling of envy; for their methods, as yet, I have a quite other feeling. The interest of this problem alone is sufficient to justify the craving of the pure mathematician for powerful methods and unexceptionable rigor.

NON-EUCLIDIAN GEOMETRY

But I turn to another matter. It is an old view, I suppose, that geometry deals with facts about which there can be no two opinions. You are familiar with the axiom that, given a straight line and a point, one and only one straight line can be drawn through the point parallel to the given straight line. According to the old view the natural man would say that this is either true or false. And, indeed, many and long were the attempts made to justify it. At length there came a step which to many probably will still seem unintelligible. A system of geometry was built up in which it is assumed that, given a straight line and a point, an infinite number of straight lines can be drawn through the point, in the plane of the given line, *no one* of which meets the given line. Can there then, one asks at first, be two systems of geometry, both of which are true, though they differ in such an important particular? Almost as soon believe that there can be two systems of laws of nature, essentially differing in character, both reducing the phenomena we observe to order and system—a monstrous heresy, of course! I will only say that, after a century of discussion we are quite sure that many systems of geometry are possible, and true; though not all may be expedient. And if you reply that a geometry is useful for life only in proportion as it fits the properties of concrete things, I will answer, first, are the heavens not then concrete? And have we as yet any geometry that enables us to form a consistent logical idea of furthermost space? And, second, that the justification of such speculations is the interest they evoke, and that the investigations already undertaken have yielded results of the most surprising interest.

THE THEORY OF GROUPS

To-day we characterize a geometry by the help of another general notion, also, for the most part, elaborated in the last hundred years, by means of its group. A group is a set of operations which is closed, in the same sense that the performance of any two of these operations in succession is equivalent to another operation of the set, just as the result of two successive movements of a rigid body can be achieved by a single movement. One of the earliest conscious applications of the notion was in the problem of solving algebraic equations by means of equations of lower order. An equation of the fourth order can be solved by means of a cubic equation, because there exists a rational function of the four roots which takes only three values when the roots are exchanged in all possible ways. Following out this suggestion for an equation of any order, we are led to consider, taking any particular rational function of its roots, what is the group of interchanges among them which leaves this function unaltered in value. This group characterizes the function, all other rational functions unaltered by the same group of interchanges being expressible rationally in terms of this function. On these lines a complete theory of equations which are soluble algebraically can be given. Any

one who wishes to form some idea of the richness of the landscape offered by pure mathematics might do worse than make himself acquainted with this comparatively small district of it. But the theory of groups has other applications. It may be interesting to refer to the circumstance that the group of interchanges among four quantities which leave unaltered the product of their six differences is exactly similar to the group of rotations of a regular tetrahedron whose center is fixed, when its corners are interchanged among themselves. Then I mention the historical fact that the problem of ascertaining when that well-known linear differential equation called the hypergeometric equation has all its solutions expressible in finite terms as algebraic functions, was first solved in connection with a group of similar kind. For any linear differential equation it is of primary importance to consider the group of interchanges of its solutions when the independent variable, starting from an arbitrary point, makes all possible excursions, returning to its initial value. And it is in connection with this consideration that one justification arises for the view that the equation can be solved by expressing both the independent and dependent variables as single-valued functions of another variable. There is, however, a theory of groups different from those so far referred to, in which the variables can change continuously; this alone is most extensive, as may be judged from one of its lesser applications, the familiar theory of the invariants of quantics. Moreover, perhaps the most masterly of the analytical discussions of the theory of geometry has been carried through as a particular application of the theory of such groups.

THE THEORY OF ALGEBRAIC FUNCTIONS

If the theory of groups illustrates how a unifying plan works in mathematics beneath bewildering detail, the next matter I refer to well shows what a wealth, what a grandeur, of thought may spring from what seem slight beginnings. Our ordinary integral calculus is well-nigh powerless when the result of integration is not expressible by algebraic or logarithmic functions. The attempt to extend the possibilities of integration to the case when the function to be integrated involves the square root of a polynomial of the fourth order, led first, after many efforts, among which Legendre's devotion of forty years was part, to the theory of doubly-periodic functions. To-day this is much simpler than ordinary trigonometry, and, even apart from its applications, it is quite incredible that it should ever again pass from being among the treasures of civilized man. Then, at first in uncouth form, but now clothed with delicate beauty, came the theory of general algebraical integrals, of which the influence is spread far and wide; and with it all that is systematic in the theory of plane curves, and all that is associated with the conception of a Riemann surface. After this came the theory of multiply-periodic functions of any number of variables, which, though still very far indeed from being complete, has, I have always felt, a majesty of conception which is unique. Quite recently the ideas evolved in the previous history have prompted a vast general theory of the classification of algebraical surfaces according to their essential properties, which is opening endless new vistas of thought.

THEORY OF FUNCTIONS OF COMPLEX VARIABLES: DIFFERENTIAL EQUATIONS

But the theory has also been prolific in general principles for functions of complex variables. Of greater theories, the problem of automorphic functions alone is a

vast continent still largely undeveloped, and there is the incidental problem of the possibilities of geometry of position in any number of dimensions, so important in so many ways. But, in fact, a large proportion of the more familiar general principles, taught to-day as theory of functions, have been elaborated under the stimulus of the foregoing theory. Besides this, however, all that precision of logical statement of which I spoke at the beginning is of paramount necessity here. What exactly is meant by a curve of integration, what character can the limiting points of a region of existence of a function possess, how even best to define a function of a complex variable, these are but some obvious cases of difficulties which are very real and pressing to-day. And then there are the problems of the theory of differential equations. About these I am at a loss what to say. We give a name to the subject, as if it were one subject, and I deal with it in the fewest words. But our whole physical outlook is based on the belief that the problems of nature are expressible by differential equations; and our knowledge of even the possibilities of the solutions of differential equations consists largely, save for some special types, of that kind of ignorance which, in the nature of the case, can form no idea of its own extent. There are subjects whose whole content is an excuse for a desired solution of a differential equation; there are infinitely laborious methods of arithmetical computation held in high repute of which the same must be said. And yet I stand here to-day to plead with you for tolerance of those who feel that the prosecution of the theoretic studies, which alone can alter this, is a justifiable aim in life! Our hope and belief is that over this vast domain of differential equations the theory of functions shall one day rule, as already it largely does, for example, over linear differential equations.

THEORY OF NUMBERS

In concluding this table of contents, I would also refer, with becoming brevity, to the modern developments of theory of numbers. Wonderful is the fascination and the difficulty of these familiar objects of thought—ordinary numbers. We know how the great Gauss, whose lynx eye was laboriously turned upon all the physical science of his time, has left it on record that in order to settle the law of a plus or minus sign in one of the formulæ of his theory of numbers he took up the pen every week for four years. In these islands perhaps our imperial necessities forbid the hope of much development of such a theoretical subject. But in the land of Kummer and Gauss and Dirichlet the subject to-day claims the allegiance of many eager minds. And we can reflect that one of the latest triumphs has been with a problem known by the name of our English senior wrangler, Waring—the problem of the representation of a number by sums of powers.

Ladies and gentlemen, I have touched only a few of the matters with which pure mathematics is concerned. Each of those I have named is large enough for one man's thought; but they are interwoven and interlaced in indissoluble fashion and form one mighty whole, so that to be ignorant of one is to be weaker in all. I am not concerned to depreciate other pursuits, which seem at first sight more practical; I wish only, indeed, as we all do, it were possible for one man to cover the whole field of scientific research; and I vigorously resent the suggestion that those who follow these studies are less careful than others of the urgent needs of our national life. But

pure mathematics is not the rival, even less is it the handmaid, of other branches of science. Properly pursued, it is the essence and soul of them all. It is not for them; they are for it; and its results are for all time. No man who has felt its fascination can be content to be ignorant of any manifestation of regularity and law, or can fail to be stirred by all the need of adjustment of our actual world.

And if life is short, if the greatest magician, joining with the practical man, reminds us that, like this vision,

> The cloud-capp'd towers, the gorgeous palaces,
> The solemn temples, the great globe itself,
> Yea, all which it inherit, shall dissolve
> And . . . leave not a rack behind,

we must still believe that it is best for us to try to reach the brightest light. And all here must believe it; for else—no fact is more firmly established—we shall not study science to any purpose.

But that is not all I want to say, or at least to indicate. I have dealt so far only with proximate motives; to me it seems demonstrable that a physical science that is conscientious requires the cultivation of pure mathematics; and the most mundane of reasons seem to me to prompt the recognition of the esthetic outlook as a practical necessity, not merely a luxury, in a successful society. Nor do I want to take a transcendental ground. Every schoolboy, I suppose, knows the story of the child born so small, if I remember aright, that he could be put into a quart pot, in a farmhouse on the borders of Lincolnshire—it was the merest everyday chance. By the most incalculable of luck his brain-stuff was so arranged, his parts so proportionately tempered, that he became Newton, and taught us the laws of the planets. It was the blindest concurrence of physical circumstances; and so is all our life. Matter in certain relations to itself, working by laws we can examine in the chemical laboratory, produces all these effects, produces even that state of brain which accompanies the desire to speak of the wonder of it all. And the same laws will inevitably hurl all into confusion and darkness again; and where will all our joys and fears, and all our scientific satisfaction, be then?

As students of science, we have no right to shrink from this point of view; we are pledged to set aside prepossession and dogma, and examine what seems possible, wherever it may lead. Even life itself may be mechanical, even the greatest of all things, even personality, may some day be resoluble into the properties of dead matter, whatever that is. We can all see that its coherence rises and falls with illness and health, with age and physical conditions. Nor, as it seems to me, can anything but confusion of thought arise from attempts to people our material world with those who have ceased to be material.

An argument could perhaps be based on the divergence, as the mathematician would say, of our comprehension of the properties of matter. For though we seem able to summarize our past experiences with ever-increasing approximation by means of fixed laws, our consciousness of ignorance of the future is only increased thereby. Do we feel more, or *less,* competent to grasp the future possibilities of things, when we can send a wireless message 4,000 miles, from Hanover to New Jersey?

Our life is begirt with wonder, and with terror. Reduce it by all means to ruthless mechanism, *if you can;* it will be a great achievement. But it can make no sort of difference to the fact that the things for which we live are spiritual. The rose is no less sweet because its sweetness is conditioned by the food we supply to its roots.

It is an obvious fact, and I ought to apologize for remarking it, were it not that so much of our popular science is understood by the haste to imply an opposite conclusion. If a chemical analysis of the constituents of sea-water could take away from the glory of a mighty wave breaking in the sunlight, it would still be true that it was the mind of the chemist which delighted in finding the analysis. Whatever be its history, whatever its physical correlations, it is an undeniable fact that the mind of man has been evolved; I believe that is the scientific word. You may speak of a continuous upholding of our material framework from without; you may ascribe fixed qualities to something you call matter; or you may refuse to be drawn into any statement. But anyway, the fact remains that the precious things of life are those we call the treasures of the mind. Dogmas and philosophies, it would seem, rise and fall. But gradually accumulating throughout the ages, from the earliest dawn of history, there is a body of doctrine, a reasoned insight into the relations of exact ideas, painfully won and often tested. And this remains the main heritage of man; his little beacon of light amidst the solitudes and darknesses of infinite space; or, if you prefer, like the shout of children at play together in the cultivated valleys, which continues from generation to generation.

Yes, and continues for ever! A universe which has the potentiality of becoming thus conscious of itself is not without something of which that which we call memory is but an image. Somewhere, somehow, in ways we dream not of, when you and I have merged again into the illimitable whole, when all that is material has ceased, the faculty in which we now have some share shall surely endure; the conceptions we now dimly struggle to grasp, the joy we have in the effort, these are but part of a greater whole. Some may fear, and some may hope, that they and theirs shall not endure for ever. But he must have studied nature in vain who does not see that our spiritual activities are inherent in the mighty process of which we are part; who can doubt of their persistence.

And, on the intellectual side, of all that is best ascertained, and surest, and most definite, of these; of all that is oldest and most universal; of all that is most fundamental and far-reaching, of these activities, pure mathematics is the symbol and the sum.

H. F. Baker

WORK GOING ON AT KILAUEA VOLCANO

For the past three months the "fires of Pelé" have been comparatively low, the conditions in the active pit of Halemaumau being that of unusual quiescence. The level of the bottom has also remained lower than at any other time since last fall, when it had a depth of about 700 feet. The last plane-table measurement obtained gave a depth of 550 feet and the subsequent change has been small.

Since its late maximum height of about 350 feet below the rim, in January of this year, the liquid lava lake has in its general movement been dropping, though a rise in June and July, 1912, presented an activity greater than any other recorded during the past thirty years. There was a molten lake 650 feet long by 450 feet wide. As many as six hundred fountains of liquid magma played simultaneously and threw the molten spray to heights of twenty to thirty feet, accompanied by a sound like the roar of heavy ocean surf. In December. after intermittent declines, the level of the lake again rose, though to a lesser altitude and accompanied with decreased activity; this condition continuing until the middle of February of this year. Since then the resultant effects have been a lowering of the surface of the lava column until, on May 1, it disappeared from all view either by day or through incandescence at night.

The lowering of the lava column was naturally accompanied by landslides due to the non-support of lower portions of the crater walls. Some of the avalanches were of considerable magnitude and duration; they gradually grew less in sound frequency and volume until, during the latter part of the month (June), they nearly ceased. Fumes and vaporous emanations have largely obscured the inner pit during the past months, and until lately the best views gained at brief intervals have shown the bottom to be largely free from molten lava. Some dozen steaming outlets surrounded with sulphurous deposits have at times revealed themselves in the bottom of the sunken well, in whose very lowest point a funnel-shaped depression descending into unknown depths has been momentarily disclosed. On the ninth of May an unusual detonation was heard toward the central portion of the pit and this has been succeeded by steam explosions resembling blasts from a locomotive's funnel. In accordance with the working hypothesis at the Hawaiian Volcano Observatory, the molten magma is due to rise on the approach of the summer solstice.

WORK AT THE VOLCANO OBSERVATORY

Since January, 1912, regular routine work has been going on in the Observatory of the Massachusetts Institute of Technology, on the very edge of the precipitous-sided caldera of Kilauea. In the Whitney Laboratory of Seismology built in the observatory cellar above steam cracks and heated from their emanations, four large seismographs are installed, including two heavy 100-kilogram Bosch-Omori trinometers, and one ordinary Omori seismograph for the registration of strong local earthquakes; and also one heavy Omori trinometer.

On May 19, Greenwich time, the heaviest shock of immediate origin yet recorded by the instruments was observed. It was felt by us at the Volcano House very distinctly, and even more at Hilo, thirty miles distant.

Ordinary microseismic motion has been constantly recorded by the instruments on the rim of the volcano's crater, and there are more rapid movements which have, in view of their obvious origin, been designated as "volcanic vibrations."[1]

On the very edge of the active Halemaumau, in the rough building of the Technology Volcano Station, a two-component Omori horizontal pendulum trinometer is installed on the concrete pier placed by the U. S. Geological Survey as a bench mark during the survey last year for the special map of the "proposed Kilauea Volcano National Park."

The instruments at the observatory will probably be connected with telephone at the brink of the lava lake, so that one standing on its very edge may correlate his observations with those being recorded two and one half miles away on the high surrounding edge of the Kilauea Sink; it will thus be possible to note the seismic effects of changes in molten magma, explosions, landslides, etc., which occur within a volcano's crater. Had such instruments been installed near the craters of Pelé and La Soufrière during the memorable 1902 eruptions they would not only have been of service to science, but in informing the distracted remnant of the populations in regard to the nature of the subsequent seismic disturbances.

Among the work being carried on under Director Jaggar are: photographic record of phases of volcanic activity, measurements of the surface of the magma column, experimental work with microphones, cinematographic registration of the activity of the molten lava, spectroscopic study of volcanic flames, optical pyrometry applied to the molten magma in the field, studies in the temperature of fumaroles and solfataras, as well as other investigations relating to the geology, mineralogy, petrography and natural history of Kilauea.

STUDIES FROM KITE PHOTOGRAPHY

In connection with the somewhat novel work now being conducted at Kilauea under

[1] H. O. Wood, *Bull. Seismo. Soc. of Am.*, Vol. III., No. 1.

the auspices of the geological department of Harvard University, of reproducing the volcano in naturalistic relief, it is proposed to make a series of aerial photographs from kites flown at heights of from one to several miles above the crater and adjacent region. Not only will the data obtained be applied to supplement the photographic survey just completed after three months of field work, itself probably the most comprehensive of its kind yet made for the reproduction of a land-form type, but it is hoped there may be secured an opportunity of novel comparison with lunar craters, which are more nearly approached by the Hawaiian type than by any others known to lie on the earth's surface. The kite photography will be conducted by expert F. W. Haworth, of Pittsburgh, who has developed this subject and pertaining apparatus to unequaled perfection.

ATTEMPT AT ACCURATE LAND RELIEF BY AMERICAN GEOLOGISTS

Primarily the purpose of the aerial photography is to furnish checks for and to supplement the data of the terrestrial, linear and photographic surveys, so that complete record of the surface forms of Kilauea will be obtained.

The aid of aerial photography in obtaining data for reproducing land in relief was employed in 1902, when the city of Washington was modeled for the U. S. Senate—views from a captive balloon—but this will probably be the first instance where kite photography has been called in to supplement the data requisite to construct a naturalistic model.

One of the oldest means employed for earth representation has naturally been actual relief, since it is the most truthful and indeed the only complete medium in which the solid world can be expressed, but strange as it may seem comparatively little attention has been given to its rational or scientific side, its aspect as a study in natural phenomena embodying for adequate treatment the observation, research and understanding which natural science demands. Thousands of diagrams in relief exist which place the arbitrarily taken points on some map into three dimensions, with little regard to the existing form and appearance of the part of the globe represented (or rather misrepresented), but they have neither been like, nor looked like, anything natural on earth. Those who understand the meaning of an ordinary map can see that the placing of its conventional data in a form of relief can never result in a true reproduction of the natural forms of earth surface, which for competent exposition must call for field observation and collection of the necessary field facts.

In the biological sciences similar procedure is well established, so that there are in our museums to-day specimens, especially of animal and plant life, which give forceful expression of the truth and vitality of the living outdoor world. Even more is there need of comparable naturalistic specimens in the earth sciences, for while most of the forms of botany and zoology are of size to be readily viewed, those of the earth's surface are so extensive and often complex that they can rarely be well comprehended in the field where frequently but a small portion of a unit is to be seen at once. Too long have geology and geography been without this unrivaled means for illustrating and forcibly interpreting the forms with which they deal, too long have the earth sciences been lacking adequate representation in the most comprehensive of all the natural arts, the one which rightly belongs to and can so richly enhance these sciences. There are signs, however, of an awakening. Men whose views have permitted seeing outside the customary methods of procedure have begun to recognize some of the need and value of the new work, and the Kilauea Crater problem now being undertaken is a result.

Kilauea Crater is situated on the island of Hawaii, American territory, within the "Proposed National Volcano Park." So new is the work of naturalistic land relief in this country that it may be said that scarcely a single American land form has been so reproduced (excellent work has already been done

in Europe and some representation of foreign types has been effected in the United States), hence the naturalistic reproduction in relief of Kilauea should mark two significant steps; first, representation in the new way of an American land-form type, and second, the entry of American geologists into this field, so useful in the promotion of their science.

Geo. Carroll Curtis
Hawaiian Volcano Observatory,
Kilauea Crater,
July, 1913

SCIENTIFIC NOTES AND NEWS

A tablet, recording the place of birth of Sir William Turner, the distinguished anatomist, principal of the University of Edinburgh, has been unveiled in his native town of Lancaster.

At the meeting of the section of tropical medicine and hygiene of the recent International Medical Congress, Sir Patrick Manson was presented with a gold plaque. It bears his portrait and on the other side an allegorical group representing science triumphing over disease in a tropical landscape.

Col. William C. Gorgas has applied for four months' leave of absence in order to accept the invitation to advise on the sanitary conditions in Johannesburg, South Africa.

Dr. Adolf Hurwitz, professor of mathematics at the Zurich Polytechnic School, has been elected a member of the Accademia dei Lincei, Rome.

Dr. Theodor Neubürger, of Frankfort, known for his contributions to hygiene and anthropology, has celebrated the sixtieth anniversary of his doctorate.

Colorado College at its last commencement conferred the honorary degree of Sc.D. on Professor Theodore D. A. Cockerell, who holds the chair of zoology in the University of Colorado.

Sir James Grant, of Ottawa, was made an honorary life member of the Canadian Medical Association at its recent meeting.

Dr. W. L. Tower, associate professor of embryology in the University of Chicago, has gone to South America to gather material for the new bionomic laboratory just completed at the university. Professor Tower has been made curator of the laboratory, which will be equipped for the study of genetics and the problems of experimental evolution.

Dr. George H. Shull, of the Station for Experimental Evolution of the Carnegie Institution, has been granted a year's leave of absence, and will spend the greater part of the year in Berlin, in study and writing. He sailed on September 12 and will participate in the Generalversammlung der Deutschen Botanischen Gesellschaft which meets in Berlin on October 5. His paper will be on "Chlorophyllfaktoren und Buntblätterigkeit bei *Lychnis dioica*."

Dr. Frederick A. Saunders, professor of physics at Syracuse University, is spending abroad a year's leave of absence. He will visit foreign laboratories and carry forward spectroscopic research in Professor Kayser's new laboratory at Bonn.

Saul Epsteen, professor of engineering mathematics at the University of Colorado, has resigned to accept the position of insurance commissioner of Colorado.

The Permanent International Eugenics Committee, which met in Paris on August 4, decided to hold the next International Congress in New York during September, 1915. Major Leonard Darwin presided, Mrs. Gotto acted as secretary, and the following countries were represented: England (Dr. Edgar Schuster), America (Dr. F. A. Woods), France (M. Lucien March), Germany (Professor A. Ploetz), Italy (Professor C. Gini), Denmark (Dr. S. Hansen), Norway (Dr. J. A. Mjöen).

Dr. M. P. Ravenel, head of the State Hygienic Laboratory, Wisconsin, presided over a session of the Fourth International Congress on School Hygiene devoted to university health. He also made an address on bovine tuberculosis at the fiftieth anniversary meeting of the American Veterinarians' Association in session in New York City, September 1–5.

Dr. Tempest Anderson, an ophthalmic surgeon of York, known for his publications on earthquakes and volcanoes, died on August 20, aged sixty-nine years, while returning from the Philippine Islands.

Mr. J. R. Sheldon, formerly professor of agriculture at the Royal Agricultural College, Cirencester, has died, aged seventy-three years.

Robert Rieder Pasha, formerly professor of surgery at Bonn and afterwards inspector-general of medical schools in Turkey, has died at the age of fifty-one years.

The death is announced, as the result of an accident, of Professor C. Bourlet, professor of mechanics at the Conservatoire des Arts et Métiers in Paris.

We learn from *Nature* that by the will of Professor Emil Chr. Hansen and his wife a fund bearing his name has been established. At intervals of two or three years, beginning in 1914, a gold medal bearing his effigy and accompanied by a sum of at least 2,000 kroner is to be awarded on May 8 to the author of a meritorious publication on some microbiological subject, and recently published in Denmark or elsewhere. In 1914 the medal will be awarded to a worker in the field of medical microbiology. The president of the board of trustees is Professor S. P. L. Sorensen, the chemical department of Carlsberg Laboratory, Copenhagen, from whom all information may be obtained.

Provision has been made for the establishment of a national museum by the Dominican government in the city of Santo Domingo for the purpose of retaining and preserving in the country objects and relics of historical character connected with the discovery and development of the country. The museum is to be established in the old palace known as the house of Don Diego Colon. The sum of $20,000 has been appropriated by the National Congress for repairing the building.

The Field Museum of Natural History has arranged its thirty-ninth free lecture course on science and travel for Saturday afternoons, at three o'clock, as follows:

October 4—"Korea," Mr. Homer B. Hulbert, Springfield, Mass.

October 11—"The Scenery and Resources of Alaska," Professor Lawrence Martin, University of Wisconsin.

October 18—"The Physical Basis and Determination of Sex," Dr. Horatio H. Newman, the University of Chicago.

October 25—"Our Forests," Mr. Huron H. Smith, assistant curator of dendrology.

November 1—"Zoological Collecting in South America," Mr. Wilfred H. Osgood, assistant curator of mammalogy and ornithology.

November 8—"The Inhabitants of Fresh Water," Dr. Victor E. Shelford, the University of Chicago.

November 15—"Migration of Plants," Professor L. H. Pammel, Iowa State College.

November 22—"The Joseph N. Field South Pacific Expedition," Dr. A. B. Lewis, assistant curator of African and Melanesian ethnology.

November 29—"New Zealand," Dr. Carlos E. Cummings, Buffalo Society of Natural Sciences.

The Macbride Lakeside Laboratory, located on West Lake Okoboji, Iowa, has just closed its most successful session, under the direction of Professor Thomas H. Macbride. Courses were offered in botany, zoology and geology, special emphasis being placed on field work. The laboratory was established in 1909 by the alumni of the State University of Iowa, and was named in honor of its director. It is affiliated with the colleges of the state through the state university, and is devoted to research by special students and teachers of the natural sciences. The work was in charge of the following staff: Professor Thomas H. Macbride, University of Iowa, and Mr. A. F. Ewers, McKinley High School, St. Louis, botany; Dr. T. C. Stephens, Morningside College, general zoology and ornithology; Professor J. C. Carman, University of Cincinnati, geology; Professor C. E. Bartholomew, Ames, entomology. Special series of lectures were given by Dr. Lynds Jones, of Oberlin, on ornithology, and by Professor L. H. Pammel, of Ames, on plant diseases.

IT is stated in *Nature* that the Institut International de Physique Solvay has a sum of 20,000 francs available for the encouragement of experimental work in physics and physical chemistry, particularly for investigations on radiation phenomena and for studies of the theory of energy quanta and of molecular theories. Grants from the fund will be awarded, without distinction of nationality, by the administrative commission of the institute on the recommendation of the international scientific committee. The administrative commission is composed of Professors P. Heger, E. Tassel and J. E. Verschaffelt, Brussels, and the scientific committee of M. H. A. Lorentz, president, Haarlem; Mme. M. Curie, Paris; M. Brillouin, Paris; R. B. Goldschmidt, Brussels; H. Kamerlingh-Onnes, Leyden; W. Nernst, Berlin; E. Rutherford, Manchester; E. Warburg, Berlin, and M. Knudsen, secretary, Copenhagen. Applications for grants should be made before September 15 to Professor H. A. Lorentz, Zijlweg 76, Haarlem, Holland.

SIX million acres of withdrawn public lands were restored to entry during the months of May and June upon approval by the Secretary of the Interior of the recommendations of the U. S. Geological Survey. This action was the result of examination and classification of the lands by the survey, those restored either having been found not to be valuable for power sites, reservoirs, coal, phosphate or potash deposits, or having been definitely valued as coal lands, and rendered available for purchase under the coal-land law. Of these lands relieved from coal withdrawal nearly two and a half million acres were in the state of Colorado. Five and a half thousand acres were also withdrawn in Colorado as water-power sites. In Idaho 1,100,000 acres of coal and phosphate withdrawals were classified and restored, and for water-power sites approximately 10,000 acres were withdrawn and about the same acreage restored. In Montana 250,000 acres were restored as being noncoal-bearing and about 1,000 acres as not valuable for water-power sites, while about 150 acres were withdrawn for that purpose. In North Dakota nearly 1,400,000 acres in coal withdrawal were classified and restored. In Oregon approximately 75,000 acres were restored as non-oil-bearing lands and about 12,000 acres were withdrawn for water-power or reservoir sites. In South Dakota over 330,000 acres were relieved from the coal withdrawal. In Utah about 1,500 acres were withdrawn for water-power sites. In Wyoming over 47,000 acres of coal withdrawals were reopened to entry and purchase; approximately 87,000 acres were withdrawn for classification as to whether they are oil-bearing lands, and about 304,000 acres were restored as nonphosphate lands. For all states the total withdrawals during the months of May and June were over 116,000 acres, and the total restorations were over 6,000,000 acres. The total outstanding withdrawals on July 1 in all the public-land states amounted to 68,609,289 acres, of which more than fifty-eight million acres are in coal-land withdrawals. These lands are held pending classification by the Geological Survey, and as rapidly as they are found to be mineral bearing they are either valued and placed on sale (as in the case of coal lands), definitely reserved pending appropriate legislation by congress to provide for their disposition (as in the case of potash or phosphate lands), or held subject to development under departmental regulations (as in the case of water power or reservoir reservations); or if they are found to be nonmineral in character they are restored to public entry. This work of classification and valuation is being prosecuted by the Geological Survey as rapidly as the appropriations provided by congress will permit.

THE report of the Royal Commission on Industrial Training and Technical Education in Canada, instituted three years ago, has now been made public. According to foreign journals the report suggests that a fund of £600,000 be provided annually by the Dominion for a period of ten years, and be divided among the provinces on the basis of population for the promotion of higher technical education and industrial training, while for elementary

schools teaching manual training and domestic science a grant of £70,000 a year for ten years is recommended. The report also proposes the establishment in each province of a board qualified to carry on industrial training. It advocates the provision of suitable and adequate apparatus and equipment for teaching purposes, the foundation of scholarships for students, the engagement of experts with experience in industrial training, and the creation of central institutions to supplement the work carried on by the provincial and local authorities. Workers in factories whose main task is to attend or to operate machines should, it is suggested, receive instruction which would develop all-round skill and increase their interest beyond the routine of automatic operations. Such training should be provided as will conserve and develop occupations in which skilled handicraft is required. The interests of the rural population should be preserved so far as possible by industrial training and technical education suitable to the needs of its workers. The needs of girls and women for organized instruction and training in housekeeping and home-making under modern industrial conditions should be recognized. The report also recommends that schools for fishermen should be established, and that provision be made for instruction in packing and curing. The distinguishing characteristic of the report is the attention which it gives to the problems of the rural communities.

THE U. S. Geological Survey has just issued, as an advance chapter from "Mineral Resources of the United States," a report by Alfred H. Brooks on the mine production of precious and semi-precious metals in Alaska in 1912. Metalliferous mining in Alaska, says Mr. Brooks, made important advances last year. Although the output of gold placers was less than in 1911, the installation of large plants, notably of dredges, in many districts is encouraging for the future of this industry. More important was the progress made in lode gold mining, the output of which was greater than in previous years. Copper mining also advanced, partly because several large plants increased their output, partly because a number of small mines were developed on account of the high price of copper. The development of the coal fields still awaits the establishment of a definite policy in regard to the disposition of the public coal lands. The delay in securing cheap fuel for the territory has now for many years caused a stagnation in many industries. Railway construction and, to a certain extent, railway operation have stopped and many mining enterprises have been hampered if not entirely abandoned on account of the uncertainty as to the fuel problem. Very few Alaskans have any direct interest in coal claims or in mining, but the entire population of the territory is desirous of seeing the coal fields developed, because it is believed that this will bring about advancement in many other industries. Above all, it will encourage the operation and the construction of railways, which are all important to the territory. The total mine production of gold, silver and copper in Alaska in 1912 was valued at $22,285,821, against $20,505,664 in 1911, an increase of $1,780,158. The value of the gold production of Alaska last year is estimated at $17,145,951, that of silver at $316,839. The copper output of Alaska for 1912 was 29,230,491 pounds, valued at $4,823,031, an increase from 1911 of 1,962,613 pounds.

UNIVERSITY AND EDUCATIONAL NEWS

THE Florida legislature has made the following appropriations for the support and maintenance of the state institutions for higher education for the coming biennium: For the University of Florida at Gainesville, $173,500, which includes $30,000 for new law building, $23,000 for farmers' institutes and publishing bulletins, $15,000 for laboratory equipment and farm buildings for college of agriculture, $10,000 for equipment and machinery for college of engineering, $7,000 for heating plant to supply five new buildings; $5,000 for sewerage and disposal system. For the Florida State College for Women at Tallahassee, $148,000, of which $30,000 is for dining hall and equipment, $5,000 for domestic

science and women's institutes. For the Florida School for the Deaf and Blind, at St. Augustine, $85,000. For the Florida Agricultural and Mechanical College for Negroes, at Tallahassee, $24,000. For expenses of board of control, $5,500. Total, $436,000.

IT is reported from Melbourne that a pioneer colonist, Mr. W. Robbie, has bequeathed £30,000 to Aberdeen University to establish scholarships.

A PUBLIC bequest amounting to £750,000 has been made by the will of Sir William Dunn. They include £2,000 to the institute of medical science of the University of London, and £2,000 to the London School of Economics.

THE registration for the year of students in regular courses at the University of California will exceed 5,300. If the summer session students be counted in, then the year's registration will exceed 8,000. Of American universities, only Columbia is larger. The enrollment at Berkeley up to the second day of registration was 4,645, or 660 more than on the corresponding date of last year. Of the 4,645 there were 1,500 new undergraduates, and, of these 1,500 new undergraduates, 1,300 were freshmen. The graduate students numbered 531, or eighteen per cent. more than on a corresponding date last year.

OHIO STATE UNIVERSITY has introduced an apprentice course in animal husbandry that includes two years study at the university and two years of practical work on a stock farm. The student in this course spends the first year at the university; the second on a stock farm; the third year at the university again, and the fourth year on another stock farm. The students are paid for their work while on the farm. The plan has interested a number of the leading stock men of Ohio and other states, and they are cooperating with the university in carrying it out.

IN the reorganized faculty of medicine of the University of Illinois appointments have been made as follows: Dr. Albert C. Eycleshymer, St. Louis, professor of anatomy and head of the department of anatomy of the medical school; Dr. Richard Rupert, Chicago, instructor of anatomy; Dr. George P. Dreyer, Chicago, professor of physiology and head of the department of physiology, school of medicine; Dr. Bernard Fantus, Chicago, professor of pharmacology; Dr. Edgar Grim Miller, Columbia, Pa.; Dr. J. Craig Small, Chambersburg, Pa., and Dr. H. N. Walker, Harrisburg, Pa., assistant professors of physiologic chemistry; Dr. Edgar D. Coolidge, Chicago, professor of materia medica and therapeutics.

PROFESSOR CLARK W. CHAMBERLAIN has resigned the professorship of physics at Vassar College to accept the presidency of Denison University.

PROFESSOR A. L. MELANDER, head of the department of entomology and zoology at the Washington State College, Pullman, and entomologist of the State Experiment Station, has been granted a year's leave of absence for research work at Harvard University. Professor W. T. Shaw, zoologist and curator of the museum, will be acting head during the coming year. Mr. M. A. Yothers, assistant entomologist, will have charge of entomological investigations. Mr. E. O. Ellis, of the Iowa Agricultural College, has been elected to the position of instructor in entomology in the college and assistant in entomology in the Experiment Station.

DR. J. E. WODSEDALEK, of the zoological department of the University of Wisconsin, has been appointed professor of zoology and head of the department of zoology and entomology at the University of Idaho, Moscow, Idaho, succeeding Dr. J. M. Aldrich.

MR. WM. S. ALDRICH, of the Reclamation Service, has been appointed acting professor of electrical and mechanical engineering at the University of Arizona, during the sabbatical leave of absence of Professor W. W. Henley.

DR. CHRISTIAN A. RUCKMICK, of Cornell University, has been appointed instructor in psychology in the University of Illinois.

PROFESSOR W. H. YOUNG, Sc.D., F.R.S., professor of mathematics in Liverpool University, has been appointed Hardinge professor of

mathematics in the University of Calcutta, for the purpose of organizing there a new school of higher mathematics. As the duties of the post require his residence in India only from November to March, it has been arranged that he shall retain his professorship in Liverpool University.

Mr. Harold Pealing, Liverpool, has been appointed lecturer in physics in the South African College, Cape Town.

Dr. Alexander Tornquist, of Königsberg, has been invited to the chair of geology and paleontology at Leipzig.

Professor His, of Berlin, who was asked to accept the appointment of director of the medical clinic, at Vienna, as successor of Professor von Noorden, has declined.

DISCUSSION AND CORRESPONDENCE

A PECULIAR DERMAL ELEMENT IN CHIMÆROID FISHES

When recently in Washington, I was kindly allowed by Dr. Hugh M. Smith to examine the type of *Chimæra deani* Smith and Radcliffe (Philippine Islands), to see if I could discover any scale-like dermal structures hitherto unreported. Gently scraping the side of the animal, I readily procured a number of small scale-like objects, which when mounted and examined with a microscope were seen to be strongly curved rods, taking very nearly the form of a horseshoe, or of oval rings with the lower end cut off. They measured about 640 microns in one direction and 500 across, with the free ends somewhat tapering. Frequently several were attached together in a series, the top of each about 130 microns above the top of the one following. Being much interested in these peculiar structures, I asked Dr. Smith to send me material of other chimæroids, and this he very kindly did. In a young *Hydrolagus colliei* (Bennett), 5 inches long, I found the structures *in situ*. A mucus canal about 2,180 microns below the dorsal denticles was lined with these horseshoe-like structures, placed obliquely a short distance apart, so that each one partly overlapped two others, as seen from above. The free ends project along the margins of the canal, which is widely open above, and the structures obviously serve to keep the canal in shape and open.

In the works of Garman, Dean, Bridge, Jordan, etc., I find no mention of these structures; but they may have been recorded in some work not accessible to me in Colorado.

T. D. A. Cockerell

University of Colorado

LABELING MICROSCOPIC SLIDES

To the Editor of Science: I was interested in the note published in Science, by Zea Northrup, in the July 25 issue, on "A New Method for Labeling Microscopic Slides," for I have been following that method for the last five years. I have found it a very successful way in which to obtain a permanent, clear designation for the slides. It is especially valuable in labeling serial sections, for, as soon as the ribbon has been firmly attached to the slides, the glass near the end of the ribbon is easily cleaned and the label then passes through the remaining parts of the process, until finally it is covered with the balsam and cover glass. This gives complete permanency to the writing and only the destruction of the slide will result in the loss of the label. In this connection it may be interesting to some to speak of two features of numbering slides which, though probably not used exclusively by the writer, he has never seen adopted by other workers. In numbering a long series of slides which contain consecutive sections from one imbedded object it is convenient to assign a decimal number to the individual slides. The practise of the writer has been to assign a whole number to the entire embedding of a certain object preceded by the last two figures of the year number; thus if a certain flower bud is the second piece of imbedding which I have done this year the number of that flower bud is 132. Then the first slide cut from that imbedding is 132.1, or the fifteenth slide is 132.15. It may also occur that more than one piece of an object is included under the serial number 132, in which case the slide number for the fifteenth

slide would be 132.1.15 if it is made from the first cutting. This method at a glance tells in what year the imbedding is done and whether or not all of the slides on a given subject are from one piece of material or from several, so that no doubt can exist as to the history of any particular slide. Of course the figure or figures following the first two and preceding the first decimal point identify completely the subject which that slide is connected with. Incidentally this method of numbering saves the instructor's time, in case the slides are for classroom use, and enables him to assign one or more of the slides to definite students with assurance that the correct slides will be returned.

Ernest Shaw Reynolds
Agricultural College, N. D.

UPON THE DISTRIBUTION OF RHODOCHYTRIUM

During the last three or four years there has been a considerable amount of discussion as to the distribution of *Rhodochytrium spilanthidis* Lagerh. and some remarks have been made suggesting that it was rather curious that it should occur in three widely separated regions and upon three different hosts. The three regions are Ecuador, Kansas and North Carolina. In the North Carolina region upon one of its hosts, *Ambrosia artemisiæfolia* L., it was found covering a considerable area, in fact it extended pretty well from one end of the state to the other. It has since been found to cover a portion of South Carolina extending almost from the mountains to the coast.

The occurrence of the parasite at all points in South Carolina wherever I have made careful search for it has led me to believe that the distribution might be extended to cover most of the southeastern and gulf states and so up the Mississippi Valley and west to Kansas, thus connecting two of these widely separated regions. With this view in mind I wrote to a number of botanists and plant pathologists in the agricultural colleges and experiment stations of the various states covering this territory to ascertain if the parasite occurred in their respective localities. With one exception I received the reply, that so far as they were able to find, it did not occur in any of these localities.

Dr. F. A. Wolf, of Auburn, Ala., sent me specimens collected at Auburn and wrote that he had also found it at Cullman, Ala. The occurrence of the parasite in these two localities makes it very probable that it will be found in the intervening state of Georgia.

Through the kindness of Mr. A. B. Massey I received specimens from Oriole, Md., which is the most northern station for this disease, so far reported, east of the Blue Ridge and Allegheny Mountains. I believe that it may be found still further north if careful search be made for it. It seems to me that there can be no doubt of its being found in Virginia, thus connecting the Maryland and the North Carolina regions.

It is a universal fact that in looking for the parasite I have always found it upon the smooth form of *Ambrosia,* for in both North Carolina and South Carolina there is a smooth and a pubescent form of the host. It also occurs more abundantly where the soil is rather poor and sandy and has not been cultivated for at least one season previous to the occurrence of the parasite.

I also believe that a more continued search for the *Rhodochytrium* will lead to its being found so as to connect at least two of the regions reported, and it is quite possible that it may connect all three of them.

I give with this, localities additional to those already published by Dr. Geo. F. Atkinson[1] where the parasite has been found. The first three are credited to the proper persons reporting them and the rest are those in which I have collected the plant. Oriole, Maryland, Mr. A. B. Massey; Auburn, Alabama, Dr. F. A. Wolf; Cullman, Alabama, Dr. F. A. Wolf; Clemson College, S. C.; Greenville, S. C.; Ridgeland, S. C.; St. George, S. C.; Olar, S. C.; Springfield, S. C.; St. Matthews, S. C.; Yemassee, S. C.; Ninety-six, S. C.; Pendleton, S. C.; Newberry, S. C.; Central, S. C.

John G. Hall
Washington State College

[1] Science, 28, pp. 691–692, November 13, 1908.

SCIENTIFIC BOOKS

The Teaching of Physics. By C. RIBORG MANN. New York, Macmillan, 1912. Pp. xxv + 304. $1.25.

Professor Mann's well-known views on the methods of teaching high-school physics find, in his book on this subject, well-developed and orderly expression, much more thoroughly worked out and carefully arranged than was possible in his numerous earlier papers and addresses. It is only natural that a decided improvement should be the result of such change in form of presentation, and yet it would be difficult to find another development, from fragmentary form into treatise, in which the material has gained so much in value as has the subject matter in review. The volume on "The Teaching of Physics" carries a constructive tone almost from the beginning.

The main lines followed are: The development of the high school itself, from an institution used mainly as a training school for college and university, to one at present so generally appropriated by the people who support it that only a small fraction of all its graduates later enter the university; the influence exercised by college and university upon the curriculum of the high school and upon the form of the separate courses therein; the effect of such influence upon the content and methods of the physics course. This effect seems to the author to be traceable in the change from the natural philosophy of the middle of the past century, with a decided leaning toward discussions of the concrete physical problems of the arts and of every-day life, to the more abstract and disciplinary methods of the later school science. The doctrine of formal discipline receives a share of the blame for the change so traced—a doctrine which has thrown its baneful influence even over the study of the classics of our literature. After citing authorities in the field of educational psychology to prove that the hope of transfer of discipline, gained in one field to another field of mental endeavor, is a mere will-o'-the-wisp, Professor Mann urges the teachers of high-school physics to bring the science home to their pupils, to a state of usefulness such that application may be made naturally and immediately to the needs of every-day life—a thing necessary indeed if a vast majority of the pupils are to receive any appreciable benefit from the subject. He contends that such a change will be accomplished only when the content of the course concerns itself less with highly abstract ideas, less with highly developed systems of units, and more with broad general principles applicable to the real and concrete problems which the pupil, and later the man and the woman, meet in their work and recreation. A discussion of present-day text-books follows—mainly adverse criticism—and some proposed remedies are suggested in the form of new methods of approach to the more fundamental principles. To these criticisms and suggestions is added the further suggestion that only by a process of experimental development will there be evolved a satisfactory high-school course in physics, with equally satisfactory text-books. The need is for cooperative effort and study of the problem on the part of large numbers of physics teachers.

The details by means of which Professor Mann has followed these lines of development have been handled by him generally in excellent and convincing manner, though at times some of them have been thrown into prominence not altogether warranted by their importance. One easily appreciates the criticism of the somewhat dogmatic form in which statements of facts and theories are too frequently made by authors of text-books—such statements are surely enough benumbing to the pupil. The suggestion is good, also, that, so far as possible, the laboratory be used to settle points of uncertainty or of controversy raised in the class room, rather than merely to verify, by measurements, physical laws which are already known by the student far more accurately than his measurements can be made. The author shows, further, that it has been just this attitude, of desire to bridge a gap in knowledge, which has been effective in advancing the science in the past; a student trained to use the laboratory to settle problems, real to him, would be much more likely to find physics of value to him in later years—himself to be of more value to the science.

The use of concrete ideas is treated at some length in one of the chapters; the discussion is given in excellent manner. Careful distinction is made between concepts which are merely specific and such as are concrete. The use of concrete elements in leading up to the formulation of general laws and principles is fully discussed.

Many other points of interest and of real importance to the teacher are considered. For instance, the last chapter of the book is devoted to a valuable discussion of various methods of examination by which the efficiency of the work in the different features of the course may be tested.

There are, however, other points which are not so convincing. The author gives (Chapter V. and subsequent pages—cf. 109–112, 117, 123, 187) a somewhat elaborate development of the ideas that science is the result of demands made by industrial and commercial growth, and that the habits of "cooperative and democratic industry of the Germanic races" (as contrasted with the "innate, immutable ideas" of the "aristocratic Greeks") have been all-powerful in building up our modern physics. Similarly the statement is made and frequently repeated (page 166) that "the man of commerce may think that the world's accounts are settled by money; but the student of real physics . . . knows that energy is the final basis of industrial values." We may agree with these statements, or we may not, as the case may be, but when the author uses them as partial justification for the contention that the energy principle should form the unifying basis of the course in physics to the exclusion of theories and hypotheses, his main arguments for such procedure, valid enough in themselves, lose something of their due force.

Again, in the chapter on the discipline of physics Professor Mann would be more convincing if the statements concerning the transfer of discipline were held within the limits set by the authorities quoted. On page 191 is the statement "since a scientific habit of mind, when developed in physics, is not transferable, while a conscious ideal is transferable . . ."; as a matter of fact the chosen authorities would justify nothing more conclusive in statement than that such habit is "probably not" transferable. The most vigorous opponents, among educational psychologists, of the old dogma of formal discipline would probably hold the question as yet open; this much would be indicated by their recognition of some transfer of discipline, some of them explaining the residual on the theory of common elements, others on the theory of transfer of method.

Occasional references to the principle of relativity and to the principle of least action, induced apparently by the frequent use of Poincaré as authority, are likely to be misleading when found in a discussion of the teaching of high-school physics. These principles are very much in the air in these days, to be sure, but one is hardly justified therefore in stating (page 233) that "this idea of maximum efficiency is valuable as giving a first inkling of the meaning of the principle of least action."

Even though one may feel inclined, on reading the volume, to differ from some statements and may not feel justified in following Professor Mann in constructing a high-school course according to the favorite plan of the author—excluding, as far as possible, consideration of theories and hypotheses—yet there remain reasons in plenty to justify the judgment that this is a notably helpful and searching treatment of a much-harrowed field. Differing or not, as the case may be, on specific suggestions and arguments, the reader finishes the book with admiration for its spirit of helpfulness. The book is more valuable, indeed, because it is ground for some wholesome difference of opinion.

For his basic contention that physics should be made *real* to the students and evidently applicable to their every-day life, and that the students should be trained in this application, Professor Mann should have the praise and support of every serious teacher. The high-school teacher should not be left long in doubt, by college and university officers, as to the acceptability of such physics for college entrance for the relatively few high-school pupils

who later find their way to college or university. No better groundwork could be found for college or technical school physics than the ability, on the part of the student, to apply the science to his every-day problems.

The volume is one of the series which appears under the title "The Teachers Professional Library," edited by Nicholas Murray Butler. The Macmillan Company is to be commended for the attractive and substantial form which the book has been given.

F. E. Kester

Thick Lens Optics. An elementary treatise for the student and the amateur. By Arthur Latham Baker, Ph.D., Manual Training High School, Brooklyn, N. Y. D. Van Nostrand Co. 1912. Pp. ix + 131. $1.50 net.

University texts on optics, as a rule, treat first order lens theory but incompletely and the aberrations of the third and higher order scarcely at all. The average university instructor in physics regards geometrical optics as an alien subject properly disposed of in high school. Reference texts of lens theory, on the other hand, deal largely with the third order theory and fail to give an elementary comprehensive treatment of first order theory.

Baker's little lens primer well fills this gap between the university text and the special treatise and will be heartily welcomed by oculists and by manufacturers and users of spectacles and other low-power lenses. It is confined strictly to first order theory, giving a simple and able treatment of image formation and focal power of combinations of thin and thick lenses. Diagrams are plentiful and good. A great many numerical examples are given and one chapter is devoted to the experimental determination of the optical constants of lens combinations with simple apparatus. When the book is revised it would be well to adopt a less formal style and perhaps either add a chapter on the special problems of spectacle lenses or mould the whole into an introduction to advanced lens theory.

P. G. Nutting

Prisms. Their Use and Equivalents. By James Thorington, A.M., M.D., Ophthalmic Surgeon, Professor of Diseases of the Eye in the Philadelphia Polyclinic. P. Blakiston's Son & Co. 1913. Pp. 144.

This little book is based on its author's course of lectures on this subject delivered each winter at the Philadelphia Polyclinic. It deals with the use of prismatic spectacle glasses in correcting muscular defects of the eye. Methods of evaluating prisms combined with spherical and cylindrical lenses are described and a number of useful tables given. The diagnosis and measurement of imperfect muscular balance (*heterophoria*) and of deviation from parallelism (*heterotropia*) of the eyes are discussed at some length. The book is well written and well illustrated and bears evidence on every page of the author's grasp and first-hand knowledge of the subject.

P. G. Nutting

SPECIAL ARTICLES

A PARASITE OF THE CHINCH BUG EGG

In the experiments conducted this year to determine the time of the first appearance of young chinch bugs and the mortality of the eggs, a large number of eggs were collected in the field for examination. The eggs which were collected at different intervals and in different localities were examined daily. While thus examining the eggs it was noticed that some of them became dark in color instead of assuming the usual red coloring. These eggs were isolated and on May 19 there emerged from them three parasites. With these three parasites as a basis, the life history was carried through four generations, running up to July 5. Since this was the time between the two broods of the chinch bugs, it became impossible to obtain additional chinch bug eggs with which to continue the work. From July 5 to July 23 only an occasional parasitized egg was found in the field, but beginning with the latter date, parasitized eggs were found in large numbers in the corn fields and the second generation was obtained by August 10. Up to the present date

this year over 325 individual parasites have been bred out. The length of the life cycle has been found to vary from ten to eighteen days, depending on the climatic conditions.

The parasite has been found in every wheat and corn field examined around Manhattan. Of 3,101 eggs collected between April 28 and June 10, the average per cent. of parasitism was 20.8, and of 116 eggs collected at Crawford (central Kansas) the per cent. of parasitism was 16.3. The insect has also been taken at Dodge City (southwestern Kansas).

The work is still under way and a full description of the parasite together with notes on its life history and efficiency will be published later.

Mr. A. B. Gahan, entomological assistant of the Bureau of Entomology, U. S. Dept. of Agric., to whom specimens of the parasite were sent for determination, says:

> I have made a partial examination of these parasites and find them to belong to the family *Proctotrypidæ*, and they probably fall close to the genus *Telenomus*. It will require further study for me to determine definitely regarding them. It seems probable that they represent not only a new species, but possibly a new genus.

In a more recent letter Mr. Gahan writes:

> After exhausting every effort to determine the parasites of the chinch bug which you sent me and failing to find any such species described, I turned the specimens over to Mr. J. C. Crawford, of the United States National Museum, to see what he could do with them. He informed me yesterday that he had arrived at the same conclusion as myself, namely, that the species would require a new genus.

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SOME OBSERVATIONS ON THE SEXUALITY OF SPIROGYRA

THE gametes of *Spirogyra* are described in the text-books of botany as being morphologically alike. A few workers have claimed that the female gametes in certain species are larger than the male. Aside from these observations the writer knows of no published accounts of attempts to point out other differences between the male and female gametes of *Spirogyra*. A large number of measurements of the conjugating cells have been made by the writer, but no constant difference in their size has been found. Several examples were observed where the transverse diameter of the filaments producing male gametes was slightly less than that of those in which the females were formed. The male cells may be longer or shorter than or equal the length of the females. The cells of any one filament vary in length. It is, therefore, quite evident that the gametes of some *Spirogyras* can not be distinguished as male and female on the basis of their relative size.

The writer observed a few years ago that the chloroplasts of the female gametes of *Spirogyra crassa*, just after the formation of the conjugating tubes, contained a much larger amount of starch and more pyrenoids than those of the male. The pyrenoids of the male gametes were larger and the amount of starch surrounding each pyrenoid was considerably less than in the females. Practically the same kind of differences seen in the gametes of *Spirogyra crassa* were observed in three other undetermined species of *Spirogyra*. By careful fixation of material of these unidentified species, taken just before or immediately after conjugation had begun and staining in iron-hemotoxylin and erythrosin, the cytoplasm of the majority of the female gametes stained a little more darkly than that of the males. The density of the staining of the female gametes was so marked in some filaments that they could easily be distinguished from the male even when the two were not in close proximity. No examples of conjugating cells were found where the male gamete stained more darkly or in which there were more starch and pyrenoids than in the female. Every year during the past seven years, the writer has examined several hundred filaments of *Spirogyra* in which conjugation was occurring or had just taken place, and in every example, the gamete with less starch and pyrenoids was passing over to or had just united with the gamete possessing a greater amount of starch and pyrenoids. The protoplasts of any one filament

are to all appearances vegetatively alike. They differ apparently only in size. Zygotes were never found in both filaments, but only in the one containing the larger amount of food.

The difference in the number and size of the pyrenoids and the amount of starch present in the chloroplasts and in the staining reaction of the cytoplasm of the gametes, clearly indicate at least that in certain species of *Spirogyra* the male and female gametes are distinctly morphologically as well as physiologically different. Since starch is formed more abundantly in the female gametes than in the male, the female plants evidently possess a greater vegetative activity than the male plants. Blakeslee[1] in his recent studies of *Mucors* concludes that the female plants (+ strains) in diœcious forms are more vegetatively luxuriant than the male plants (— strains).

A more detailed account than is presented here will appear later.

HARLAN H. YORK

DEPARTMENT OF BOTANY,
BROWN UNIVERSITY

THE SOCIETY OF AMERICAN BACTERIOLOGISTS

SYSTEMATIC AND PHYSIOLOGIC BACTERIOLOGY

THE annual meeting of the society was held in New York City, December 31, 1912, and January 1 and 2, 1913, under the presidency of Dr. William H. Park. The sessions were held at the American Museum of Natural History, the University and Bellevue Hospital Medical College and the Rockefeller Institute. The society expressed its indebtedness to these institutions for their courtesy. The annual dinner was held on Wednesday evening, January 1, 1913, at which the president's address was delivered. Dr. Park spoke upon "The Applications of Bacteriology in the Activities of a City."

With this as his text Dr. Park traced the history of the Research Laboratories of the Board of Health of New York City, an institution which easily takes rank with the Pasteur Institute of Paris and other institutions of the kind in Europe.

[1] Blakeslee, A. F., "A Possible Means of Identifying the Sex of (+) and (—) Races in the *Mucors*," SCIENCE, N. S., 37: 880–881, 1913.

In the original work which has been done under Dr. Park's direction no other American laboratory engaged in public health work can point to so many achievements which have resulted in advancing our knowledge of infectious diseases and methods for controlling them.

The following officers were elected for a term of one year:

President—C.-E. A. Winslow.

Vice-president—Charles E. Marshall.

Secretary-treasurer—A. Parker Hitchens.

Council—W. J. MacNeal, L. F. Rettger, D. H. Bergey, H. A. Harding.

Delegate to Council of A. A. A. S.—S. E. Prescott.

The following papers were read:

The Value of Glycerinated Potato as a Culture Medium: M. R. SMIRNOW, M.D., New Haven, Conn., instructor in bacteriology and pathology, Yale Medical School.

The glycerinated potato culture medium belongs to the class of the so-called media, which as the term implies, are media of various compositions and are used only for special purposes. They may be employed as follows: (1) for the purpose of isolating microorganisms; (2) to furnish a sufficiently favorable medium for the growth of certain organisms; (3) for specific or differentiating tests; (4) to bring out special features of growth. Aside from blood media, the most frequently used of the special media are the glycerinated potato and agar, but even these are practically limited to the cultivation and the study of acid fasts. It has long been the opinion of the writer that if some of our so-called special media were put to a more general use, hitherto unknown biological features in the study of microorganisms would come to light. This was emphasized by the finding of a marked contrasting culture on glycerinated potato of a glanders bacillus, which was being isolated at our laboratories during the last year. This organism was isolated from a human case of glanders. When first obtained it gave but a faint yellow growth on plain potato, by no means the so-called honey-like growth. It was then planted on glycerine potato with more success. On this medium it gave a luxuriant growth of a bright yellow color and typically honey-like in character. It was this peculiar and striking difference in the growth of the glanders bacillus that led up to the work here outlined. The cultural characters of twenty-five microorganisms were studied on glycerine potato, plain potato and broth potato, the

two latter media being used as controls. The media were freshly made as needed. A number of potatoes were cut into cylinders, washed in running water for about an hour and then allowed to remain in a basin of water over night. One third of the lot was placed into 6 per cent. glycerine broth, and one third into plain broth for about two hours, and the remainder was left in the water. The three batches of potatoes were then tubed and glycerine broth and plain broth were poured into the tubes up to the level of the glycerinated and broth potato, respectively. The plain potato had no fluid added to it. The media were then sterilized in the autoclave at 18 lbs. pressure for 15 minutes, and then stored until used in cold place to prevent drying. The plants were all made of the same stock cultures, at the same time incubated both at 22° and 37.5° C. Each test was carried out a number of times, to assure constant results. The results obtained will for convenience be divided into three groups. The first comprising bacteria that show a striking contrast in their cultures on the different potato media; the second showing a slight difference, and the third those showing no difference. The first group includes the following microorganisms:

- Two different strains of *B. mallei* of human source.
- One strain of *B. mallei* received from New York.
- Two strains of *Actinomyces* received from Washington.
- *B. pyocyaneus*, old stock culture.
- *B. subtilis*, old stock culture.
- An unidentified spore-forming bacillus, isolated from the intestinal tract of a rabbit and designated as "B. rabbit spore."

To sum up this group: The three strains of the glanders bacillus give lighter colored, moister and more typical honey-like growths on glycerine potato. Their growth on plain potato is more brownish yellow in color and the potato is usually discolored. A metallic luster was noted on broth potato on several occasions with each strain. The *Actinomycetes* give a dry culture made up of isolated colonies, raised and of decided brown color on plain potato, whereas on glycerinated potato they give rise to a luxuriant growth of more conglomerated colonies of a honeycomb-like arrangement and of a light-yellow color. The *B. pyocyaneus* gives a brighter and deeper green pigment on the glycerine medium and a brown or green-brown slimy growth on ordinary potato. The *B. prodigiosus* gives a bright cherry-colored growth on glycerine potato and agar, at 22° C., a slight red or orange on broth potato and a faint pink on ordinary potato. It gives hardly any color at 37.5° C., on any of the media. The *B. subtilis* apparently grows better on ordinary potato, producing a heavy furred culture of brown color. On the glycerine potato it gives a rather delicate lightly furred growth of a light-yellow color. In the second group are included:

- *B. coli*, stock culture.
- *B. mucosus*, stock culture.
- *Sp. cholera*, stock culture.
- An unidentified organism isolated from rabbit feces, here designated as "B. rabbit feces."
- An unidentified pleomorphic bacillus isolated from a contaminated plate.
- A mould.

In general it may be stated that these organisms do not show striking differences in their growths upon the three varieties of potato. Glycerinated potato permits as a rule a much lighter colored growth, less raised, and often more homogeneous in character. In the third group are included the diphtheria, typhoid, dysentery and grass bacillus, the *Streptococcus pyogenes*, *Staphylococcus aureus* (two strains), *Sarcina aurantia* and a yeast. There are no visible differences in the cultural characters of each of these organisms on the potato media under consideration. The chromogenic organisms (*Sarcina aureus*, yeast) seemed to give brighter and more intense pigment production and at times somewhat more luxuriant growths on the glycerinated potato. In conclusion the writer desires to bring to your attention that with the particular strains used glycerinated potato affords a more favorable medium for most of the twenty-five microorganisms tested. It allows more moist, more homogeneous, less raised growth characteristics, of lighter or brighter color. With the *B. prodigiosus* the color was greatly intensified. Glycerine potato is seldom discolored, whereas both broth and plain potato are frequently discolored, particularly the latter. From the above we may conclude that a more general use of glycerinated potato suggests itself.

The Preservation of Stock Cultures: A. PARKER HITCHENS, Glenolden, Pa.

For the preparation of stock bacterial vaccines it is necessary to have constantly on hand a large number of cultures of the various pathogenic bacteria. For the preparation of vaccines for the treatment of the various regional mixed infections, it is deemed necessary to collect the various species and types in each region. To keep fresh stock of any culture frequent transplantation is necessary. As the intervals between transplants vary

considerably with the different cultures, a card-catalogue system has been devised. Under this system each culture is represented by a card, upon which are recorded all the dates of transplantation as the fresh cultures are made. The cards are kept in a file, with each card placed under the date at which the next transplant of its culture is necessary. The work upon the cultures each day is carried out in accordance with the cards filed under that date. During the intervals between transplants, all cultures except the *B. influenzæ*, gonococcus and meningococcus are kept cold. Five dates of each culture are kept and the tube of most recent date is unopened. In order to keep a large number of cultures constantly on ice, we have had a refrigerator constructed especially for this purpose. The refrigerator, well insulated, is about seven feet long, six feet high and two feet in depth. It is divided into six large compartments, three above and three below. The middle compartment of the upper row contains the ice, and it is always filled to its capacity, 500 pounds. This quantity of ice maintains a temperature of 10° to 15° C. throughout the entire refrigerator. The refrigerator is well drained and the open framework of the interior allows free circulation of air. Five compartments are devoted to the cultures. These compartments are provided with drawers, which slide in grooves and are easily removed. Each drawer is of such dimensions that two crates of cultures fit end to end within it. The total number of drawers is 63 and the total capacity 1,600 cultures. The front of each drawer is provided with a groove into which a card is fitted designating the contents of the drawer. With this refrigerator and our system of transplanting we are able to keep ready for immediate use a fresh supply of all the cultures necessary for the preparation of bacterial vaccines.

A Refinement of the Technic of Quantitative Bacteriological Analyses: W. D. Frost, Boston, Mass.

It is generally recognized that the measured quantities of water, used for dilution, lose in volume during sterilization and upon standing. The exact amount of this loss or the means of preventing it are apparently not generally understood. In an extended series of experiments it is found that the loss varies from 1 to 8.8 per cent. and that the average is 5.07 per cent. Various types of autoclaves are tested and it is found that there is considerable variation in the different types. The loss is evidently due to the ebullition and escape of steam, especially during cooling. This loss can be prevented by closing up the autoclave cold, as is frequently done in sterilizing blood serum. When closed in this way the autoclave is not always efficient in the time or at the pressure ordinarily used. In order to insure sterilization it will be necessary to extend the time, increase the pressure or sterilize on two consecutive days. The evaporation due to standing a few weeks is equal to the loss in the autoclave. This is not prevented by a thin paper cap. Paraffined paper is recommended, also cork stoppers covered by a thin layer of cotton instead of an ordinary cotton plug. In using the bottles after making the dilution it is suggested that the sterile side of this cap be forced into the mouth of the bottle with the cork. This permits efficient shaking.

The Significance of the Time at which Gas is produced in Lactose Peptone Bile: William W. Browne, Ph.D., College of the City of New York.

During the summer of 1912 routine bacteriological examinations of oysters of Narragansett Bay were made under the direction of Professor F. P. Gorham, of Brown University, with the hope of determining the extent of the pollution of the oyster beds of Rhode Island by the sewage of the neighboring cities and towns. The examinations were made according to the methods proposed by the American Health Association. Lactose peptone bile was used as a presumptive test to indicate the presence of members of the *Bacillus coli* group and other lactose fermenters of intestinal origin. (1) Lactose peptone bile tubes inoculated with the shell liquor of oysters taken from 119 different beds produce the greater part of their gas by the end of the forty-eighth hour. (2) Lactose peptone bile tubes inoculated with the shell liquor of oysters taken from polluted areas produce almost all their gas by the end of the forty-eighth hour. (3) Lactose peptone bile tubes inoculated with the shell liquor of oysters taken from districts comparatively free from pollution produce the greater part of their gas by the end of the seventy-second hour. (4) Consideration of this temporal factor in the production of gas in lactose peptone bile might aid in the determination of whether the pollution was recent or remote.

A Comparative Study of the Smith Fermentation Tube and the Inverted Vial for the Determination of Sugar Fermentation: William W. Browne, Ph.D.

During the sanitary survey of Narragansett Bay conducted under the direction of Professor F. P. Gorham, of Brown University, a comparison was made of the efficiency of the Smith fermentation tube and the inverted vial as used in the presumptive test with lactose peptone bile to indicate the presence of members of the *Bacillus coli* group and other lactose fermenters of intestinal origin. Fermentation tubes and inverted vials containing lactose peptone bile were inoculated with the shell liquor of oysters taken from polluted areas and the following results were obtained:

Percentage of Efficiency

	Cubic Centimeter	
	24 hrs.	48 hrs.
Fermentation tube	84.6%	94.3%
Inverted vial	92.3%	96.1%
	One Tenth Cubic Centimeter	
	24 hrs.	48 hrs.
Fermentation tube	86.5%	90.3%
Inverted vial	59.5%	84.6%
	One Hundredth Cubic Centimeter	
	24 hrs.	48 hrs.
Fermentation tube	32.6%	55.7%
Inverted vial	23.0%	42.3%

Resistance of Microorganisms Suspended in Glycerine or Oil to the Sterilizing Action of Heat: C. J. Bartlett and F. B. Kinne.

Dreyer and Walker have recently reported the results of heating spores suspended in glycerine and oil. They show that spores in glycerine were not killed with certainty after heating two hours at 1½ atmospheres, 2 hours at 1¼ atmospheres or one half hour at 2 atmospheres. In our experiments we have worked with the *Staphylococcus aureus*, with the *Bacillus anthracis* and with the *Bacillus subtilis*, and with a bacillus with very resistant spores, apparently the *Bacillus vitalis*. These have been heated in glycerine, water, olive oil, cottonseed oil and paraffin for different periods at the temperature of boiling water and in the autoclave at 7½ lbs. pressure and at 15 lbs. pressure. The *Staphylococcus aureus* is quickly killed in all of these, even at the temperature of boiling water. The spores of the anthrax bacillus and of *B. subtilis* are quickly killed in boiling water, usually in three minutes or less. In glycerine they have been found alive after one and one fourth hour at this temperature and in oil after fifty minutes, and in the autoclave after heating in oil fifteen minutes and in glycerine in ten minutes at 7½ lbs. In water they do not live after five minutes at this pressure. The spores of the *B. vitalis* are killed in about one half of these tests by heating in boiling water for two hours, while in oil and glycerine they resisted this temperature for two hours in every instance. After heating in the autoclave they were found alive in oil at 15 lbs. for two hours and in glycerine after one and a half hour, but not longer. In water they were never found after twenty minutes at 7½ lbs. and after ten minutes at 15 lbs. It is evident that spores are more resistant to the action of hot oil and glycerine than to that of hot water.

The Comparative Viability of Pneumococci on Solid and on Fluid Culture Media: L. J. Gillespie, Hospital of the Rockefeller Institute for Medical Research.

The following facts have been observed: (1) Broth which is perfectly suited for the growth of copious cultures of the pneumococcus often requires many more organisms (frequently a million times as many) to initiate growth than does agar. (2) Cultures which when fresh from the animal body show a marked effect become on cultivation upon artificial media indifferent in their requirements. (3) Certain cultures (of any strain) show no effect even when fresh from the body. (4) Differences in chemical composition of broth and of agar play little or no part because an imitation "solid" medium, prepared from filter paper and broth, serves nearly as well as agar. (5) The possibility that insufficient aeration in the case of broth plays any rôle is ruled out by comparing agar plates with agar shake cultures. These phenomena may be explained if we suppose that the pneumococcus sometimes requires for its multiplication that substances from the animal body be present in the immediate environment of the cocci, the concentration of which can be too far reduced in the case of broth by diffusion aided by convection. If we suppose rather that the necessary substances are produced by the pneumococci themselves we may assume that such substances are always necessary, and that during acclimatization to artificial media the capacity for such metabolism is increased.

Studies of the Subtilis Group: Karl F. Kellerman and Edna H. Fawcett, Bureau of Plant Industry, Washington, D. C.

The *Subtilis* group includes the spore-forming aerobic and facultative anaerobic bacteria which liquefy gelatine. Numerous cultures of members of this group have been obtained from various sources. Biometrical study of their acid produc-

tion, ammonia production, and the reduction of nitrates, together with careful comparison of their morphology, has shown the necessity for allowing greater range in the description of *Bacillus subtilis, B. cereus, B. mycoides* and *B. megatherium*. No decision has as yet been reached regarding the validity of *B. asterosporus* or *B. ruminatus*. For the first four species named the following synonymy is submitted:

B. subtilis

B. subtilis Cohn (Emend) 1876, (Flugge) 1886, (Zopf) 1883.
mesentericus vulgatus Flugge, 1886.
mesentericus fuscus Flugge, 1886.
liodermus Flugge, 1886.
aerophilus Flugge, 1886.
lævis Frankland, 1887.
mesentericus fuscus Trevisan, 1889.
mucosus Zimmermann, 1894.
destructans Wright, 1895.
mesentericus ruber Globig (Flugge), 1896.
leptosporus Klein, 1900.
sessilis Klein, 1900.
pumilis Gottheil, 1901.
simplex Gottheil, 1901.
mesentericus Chester, 1903.
malariæ Klebs. (Original not consulted.)

B. cereus

B. cereus Frankland, 1887.
ulna Cohn, 1875. (Incomplete description.)
ramosus liquefaciens Flugge, 1886.
subtilis Frankland, 1887.
subtilis Sternberg, 1890.
subtilis Eisenberg, 1891.
petroselina Burchard, 1892.
cursor Burchard, 1892.
loxosus Burchard, 1892.
goniosporus Burchard, 1892.
turgescens Burchard, 1892.
limosus Russel, 1894.
capillaceus Wright, 1895.
crinitum Wright, 1895.
subtilis Wright, 1895.
subtilis Lehman and Neumann, 1896.
ellenbachensis Stutzer and Hartleb, 1898.
fusiformis Gottheil, 1901.
stoloniferus Pohl, 1903.
lutulentus Kern. (Original not consulted.)

B. mycoides

B. mycoides Flugge, 1886.
figurans Crookshank, 1886.
bassicæ Pommer, 1886.
bacterium casei Adametz, 1889.
ramosus Frankland, 1889.
radicosus Eisenberg, 1891.
implexus Zimmermann, 1890.
intricatus Russel, 1892.

B. megatherium

B. megatherium De Bary, 1884.
tumescens Zopf, 1885.
lacteus Lembke, 1897.
petasites Gottheil, 1901.
graveolens Gottheil, 1901.
granulosus Russel, 1892.

Parasites found on Rats in Providence: GEORGE H. ROBINSON, Brown University.

The examination of the rats of Providence for evidence of plague and for the occurrence of parasites has extended over a period of six months, from July to December. During this time 342 rats from different parts of the city were inspected. No evidence of plague was found. The specimens were evenly divided as to sex. As to species there were 333 specimens of *Mus norvegicus*, 2 of *Mus alexandrinus*, 1 of *Mus rattus*, 4 which showed evidences of being a cross between *Mus norvegicus* and *Mus alexandrinus*, 1 apparently a cross between *Mus norvegicus* and *Mus rattus*, and 1 *Mus musculus*. Of these 342 rats, 57 per cent. were infected with fleas, 21 per cent. with mites (*Lælaps echidninus*) and 24 per cent. with lice (*Polyplax spinulosus*). 2,053 fleas were found, consisting of 75 per cent. *Xenopsylla cheopis* Rothschild, 22 per cent. *Ceratophyllus fasciatus* Bosc, 2.5 per cent. *Ctenopsylla musculi* Duges and 0.5 per cent. *Ctenocephalus canis* Curtis. No evidence of a regional distribution of the fleas was observed. A marked seasonal variation was noted, the average flea per rat for July–September being 10.2, while that for October–December was 3.7. The largest number of fleas taken from a single specimen was 300. No relation was found between a filthy habitat and the number of fleas, for the average flea per rat was higher, in general, for the rats from dwelling houses and restaurants than for those from stables and docks. 12 per cent. of the specimens were affected with sores. Parasites, the encysted form of the cat tapeworm, *Tænia crassicollis*, and the ova of some undetermined form were found in the liver of 7 per cent. of the rats. This condition occurred most frequently in the rats obtained from markets.

Comparison of Two Methods for Bacterial Analysis of Air: G. L. RUEHLE and H. A. HARDING.

Report of progress in the comparison of the Rettger method with the official sand filtration method. An exact comparison was found to be difficult to obtain and the relative value hard to estimate. Study to be continued.

A Biometric Study of the Streptococci from Milk and from the Human Throat: E. C. STOWELL, C. M. HILLARD, M. J. SCHLESINGER.

Two hundred and forty pure strains of strepto-

cocci isolated from milk and from the human throat have been compared as to their morphology, Gram stain and gentian violet reaction by the plate method, and their quantitative acid production in seven carbohydrates and related organic media. Hemolysis was studied with 92 strains. We have been able to make no correlation between the length of chain and the relation to violet stain with any other character. Seventeen out of 92 cultures gave hemolysis when streaked on blood agar plates. Five of these cultures came from normal milk, five—the most vigorous hemolizers—were from milk where udder trouble was indicated in the cow, and seven were normal throat forms. The seven substances tested showed a definite order of availability for the acid production. This order ("metabolic gradient") and the per cent. of culture yielding 1.2 per cent. or more of acid when grown at 37° C. for three days is shown in the following table:

	Per Cent.
Glucose (monosaccharide)	98.0
Lactose (disaccharide)	76.0
Saccharose (disaccharide)	65.5
Salicin (glucoside)	42.7
Raffinose (trisaccharide)	37.5
Inulin (starch)	9.0
Mannite (hexahydria alcohol)	1.5

It will be noted that the degree of availability is closely associated with the size and complexity of the substance. According to the positive reaction —over 1.2 per cent. acid—in the test substances 88 per cent. of the cultures may be placed in eight groups. The following features separate milk from throat streptococci: (1) milk organisms yield over 2.5 per cent. acid in lactose and saccharose at 37° C.; (2) they seldom ferment substances higher in the metabolic series than saccharose; (3) they readily ferment dextrose, lactose and saccharose at 20° C. On the other hand, throat streptococci (1) seldom yield over 2.5 per cent. acid in any substance; (2) over 40 per cent. of the cultures yield over 1.2 per cent. acid in either salicin or raffinose; (3) at 20° C. they almost never attack any of the seven test substances.

A Systematic Study of the Coccaceæ in the American Museum of Natural History Collection: I. J. Kligler, Department of Public Health, American Museum of Natural History.

A biometric study of 54 strains of cocci in the museum collection was made in order to test the classification proposed by the Winslows in their book on the "Systematic Relationship of the Coccaceæ." Twelve morphological and physiological tests were applied and the results recorded quantitatively whenever possible. The results corroborate the work done by the Winslows. The cocci—other than streptococci—group themselves into five distinct classes according to the pigment produced as follows: (*a*) *White pigment—Albococcus;* (*b*) *orange pigment—Aurococcus;* (*c*) *yellow pigment—Micrococcus;* (*d*) *yellow pigment and packets—Sarcina;* (*e*) *red pigment—Rhodococcus.* The other properties correlate remarkably with that of pigment production and prove that this generic division is a fundamental one. The definition of species is also based on real differences. The species recognized by Winslow were found to be valid, but the number was incomplete. Three new species were recognized (*Alb. urea, M. melitensis* and *S. aurantiaca*) and the possible existence of a few others suggested. Further study is necessary. The application of the principles of biometry to the systematic study of the Coccaceæ has yielded very successful results. It is hoped that new workers will apply this principle to the systematic study of this and other groups of bacteria.

Bacteriological Collection and Bureau for the Distribution of Bacterial Cultures at the American Museum of Natural History, New York: C.-E. A. Winslow.

In January, 1911, a prospectus, from which the following sentences are quoted, was sent out from the American Museum to the leading laboratories of the country. "The Department of Public Health at the American Museum of Natural History has equipped a laboratory to serve as a central bureau for the preservation and distribution of bacterial cultures of both pathogenic and non-pathogenic organisms, and particularly of types of new forms and varieties. It is hoped that the laboratories of medical schools, colleges, boards of health, agricultural experiment stations, etc., and those engaged in biochemical work of all sorts, will furnish the museum with cultures at present in their possession, and the laboratory is now ready to receive and care for any such cultures. Types of new species and varieties are particularly desired at the present time and as they may be isolated in the future. The laboratory, of course, can not undertake to keep on hand bacteria difficult of cultivation, such as can be maintained only for a few weeks after isolation from the body; neither can it at present supply virulent cultures which rapidly lose their virulence under laboratory conditions. It should, however, be able to furnish

cultures of organisms of all the ordinary types which can be maintained under cultivation. Pathogenic forms will be sent only to properly qualified persons.'' The value of the proposed collection was quickly appreciated. Cultures from all over the United States and Canada have been contributed freely. In all, 45 different laboratories have sent in cultures, and arrangements have been made for exchange with Professor Kraus, of Vienna, who now has charge of the famous Kral collection. On December 1, 1912, the collection included 578 strains representing 374 different named types, and in the list, which has been printed and may be obtained on application, are most of the important pathogenic and non-pathogenic species which have been definitely described.

During the period of somewhat less than two years, from January 1, 1911, to December 1, 1912, the laboratory distributed to 122 different colleges and research laboratories of the United States and Canada 1,700 different cultures, in every case without charge. It is the policy of the department to send cultures free to all teaching laboratories of college and university grade, and to all research laboratories, whether cultures are sent to us in return or not. Many cultures have been called for by teaching laboratories for use in their class work. The most important service the laboratory has been able to render, however, has been in furnishing authentic cultures to investigators who have been making a study of certain special groups, and the published papers which have resulted, in which various detailed characters of the museum types are described, of course greatly increase the value of the collection.

DAIRY BACTERIOLOGY

Transportation of Milk: M. C. SCHROEDER, M.D., assistant director, Research Laboratory, Department of Health, City of New York.

The problem of the transportation of milk is influenced chiefly by the necessity of subjecting it to the long or the short haul. Most of the smaller cities and towns receive milk from a distance of ten miles, so that milk is transported in wagons only and is delivered to the customer quite fresh. Here, icing during the warm, and protection during the cold, together with frequent inspection of the delivery wagons, and the taking of samples for bacterial tests solve the problem fairly well. New York receives about 30,000 quarts a day from about 145 such outlying farms. The greater bulk of the milk, about 1,800,000 quarts, is brought from distances of 50 to 300 miles. This milk is first drawn to the receiving station, mixed in tanks, simply aerated, or pasteurized and cooled, bottled and canned, and shipped in refrigerator cars holding 272 to 375 40-quart cans, or from 450 to 700 boxes of 12 quarts each. The most important question in the long haul is the refrigeration. Two methods of icing have been utilized. Direct (crushed ice being placed upon cans and bottles), second ''indirect'' (the ice being placed in boxes called bunkers at the end of the car). The bunkers are found to be too small for the ice necessary to keep the milk cold if the weather is hot or the journey long. Milk comes over 15 railroads and enters New York through eight terminals. Trains start in the country from 7 A.M. on, and arrive at the terminal from 9 P.M. to 2 A.M. if not delayed. At the terminal it is loaded in large trucks and is drawn one or more miles to pasteurizing or distributing centers. Here it is handled and sorted and finally loaded into smaller wagons for delivery. The milk supply of New York is safeguarded from bacterial contamination as follows: by annual sanitary inspection of the farms on which the milk is produced, and the more frequent reports of the farmers delivering the milk as to the conditions existing of production and care, by inspecting the icing of the milk and the conditions of the cans and bottles being shipped back to the creamery; by inspecting the conditions under which it is sold; it also seeks to detect the condition of production, transportation and sale by taking bacteriological samples of milk from creameries, at the railroad terminals, from wagons, pasteurizing plants, hospitals, stores, etc. Thus last year the number of samples taken and analyzed was 61,142. For the control of the milk supply, the Department of Health has only 24 inspectors for about 44,000 farms, 30 inspectors for the five boroughs and 4 inspectors taking bacteriological samples for both city and country.

Problems in Sanitary Milk Classification, with special reference to the Experience in New York City: ERNST J. LEDERLE, Ph.D., Commissioner of Health, City of New York.

In contradistinction to most other large municipalities, New York City undertakes practically the entire supervision of its milk supply from the cow to the consumer, notwithstanding that nearly all the 45,000 farms on which this milk supply is produced are located outside the city, and more than 6,000 of them outside the state. The milk

supply may become a source of danger to the public health by being infected with the germ of bovine tuberculosis, the germs of typhoid fever, scarlet fever, diphtheria and tonsillitis, by having in general an excessive bacterial growth and by not having a proper nutritive value. In view of these sources of danger, the means to be employed to make public milk supplies safe are as follows: (1) the prevention of adulteration; (2) the production of a clean milk of low bacterial count. This involves cleanliness of the cows and milkers, clean barns, clean vessels, the exclusion of dust, immediate reduction of temperature after milking, icing during transportation, the sale in sanitary stores; (3) the production of milk free from pathogenic organisms, involving the prevention of the introduction of infectious disease through human agencies, flies and dust. The general milk supply of every large city is unfit for use in infant feeding, and as the attempt to bring the general market milk to the degree of purity required for infant feeding can never be successful, the only way in which sanitary authorities can meet existing conditions is by requiring the pasteurization of all milk which is not of special grades. The official classification of milk in New York City is as follows:

Grade A:
1. Certified.
   Guaranteed.
2. Inspected milk (raw).
3. Selected milk (pasteurized).

Grade B:
1. Selected milk (raw).
2. Pasteurized milk.

Grade C:
For cooking.

The following changes are under consideration: (1) the elimination of Grade *B* (raw) entirely, and requiring it to be pasteurized; (2) the elimination entirely of Grade *C* from the retail trade; (3) an increase in the requirements for milk intended for pasteurization.

Problems in Sanitary Dairy Inspection: H. A. Harding.

Milk resembles the human race in that its value is determined by two forces, its inheritance and its environment. Inheritance fixes the amount of solids which is normal to the milk. The other elements of its food value are determined by the environment under which it is produced and handled. The problem in sanitary dairy inspection is to provide an inspection which affects the selling price of the milk. This can probably be best accomplished by establishing market grades of milk and by defining these grades in terms of the conditions surrounding the production and transportation of the milk. The value of this financial element in sanitary milk inspection is well illustrated by the Geneva milk supply. In October, 1907, all of the milk coming to this city was graded on the basis of the conditions under which it was produced. It was found that the conditions of the production of 37.5 per cent. were poor, 57.5 per cent. were medium and 5 per cent. were good. The conditions then changed so that the producers were paid on a sliding scale, making it more profitable to produce the better grades of milk. In March, 1911, the milk supply of the city graded on the same basis as above was 87.5 per cent. good and 12.8 per cent. excellent. Conditions again changed so that there was no longer this direct connection between the conditions surrounding production and the price received, and in October, 1912, the city supply on the same basis as the above was 81.5 per cent. medium, 15.7 per cent. good and 2.6 per cent. excellent. Farmers have a better financial sense than is generally supposed and sanitary milk will not be produced on a large scale until its production becomes financially more profitable than that of the dirtier grades. Details are given in *Bulletin of New York Agricultural Experiment Station.*

Notes on Yeast-like Organisms in Whey: S. F. Edwards, Bacteriological Laboratory, Ontario Agricultural College.

During the summer of 1909 some work was begun on the problem of so-called fruity flavor or sweet flavor in cheese in western Ontario. The trouble was supposedly due to yeasts or yeast-like organisms. Samples of whey were secured from twenty-five factories where this flavor was prevalent, and from these samples twelve varieties of yeast-like organisms were isolated. Some of the yeasts (so-called) were found in the whey from more than one factory, and some factories had several varieties in the whey. Three lots of experimental cheese were made up, using a starter of these organisms, and the flavors typical of different factories were produced, whereas no off-flavor was present in normal control cheese. These organisms have been retained in the laboratory and further study has been made as the time permitted. The term yeast is a misnomer, for with but one exception we have been unable to demonstrate spore production. Very little attention has been given to morphology, sole dependence for dif-

ferentiating the varieties having been placed on cultural and biological characters. A summary of these characters is given in the subjoined table.

The Cultural Characters of Whey Yeasts

+ indicates positive results. Blanks indicate no action.

For convenience the organisms are designated by letters.

	Ferments[1]				Produces Acid in						Reducing Sugars from				Peptonizes Milk	Liquefies Wort Gel[2]	Indol in Dunham, 20 Days	Indol in Uschinsky + Peptone	Ammonia in Nitrate Broth	Alkali in Litmus Milk
	Dextrose	Saccharose	Lactose	Maltose	Dextrose	Saccharose	Lactose	Maltose	Raffinose	Mannite	Saccharose	Raffinose	Starch	No Reduction in Mannite						
*A*2					+								+		+	+		+		
*A*5	+		+			+	+				+	+			+	+	+	+		
*B*2	+	+			+	+			+		+	+			+	+	+	+	+	+
*B*4	+	+			+	+			+	+	+	+			+	+	+	+	+	
*D*1															+		+	+	+	+
*J*1	+	+	+		+	+	+					+				+	+	+	+	
*J*2	+					+		+			+				+	+	+	+	+	+
*K*1	+	+		+		+		+	+			+			+	+		+	+	
*K*3	+	+			+	+	+				+	+						+		+
*O*1	+				+		+		+		+	+				+		+		+
*P*1	+	+	+		+	+	+					+			+	+		+		
*X*2											+	+				+			+	
Control																				

All of the organisms made scanty growth in Cohn. Yeasts *D*1, *J*2, *P*1, *X*2 made scanty growth in Uschinsky; the others none. Organisms *A*2, *J*1, *P*1 produced a marked pineapple flavor in wort agar plates, and *A*5 and *J*2, marked strawberry flavor in the same medium. Further work with these organisms is planned.

The Action of Bacillus Bulgaricus in Suppressing Gassy Fermentations in Cheese-making: C. F. Doane, Dairy Division, U. S. Department of Agriculture.

It was found that pure cultures of *bulgaricus* could be used with perfect results in suppressing the undesirable fermentations, principally gas, which have worried Swiss cheesemakers in the past. There seems to be a difference in the efficiency of different strains of *bulgaricus* for this purpose without respect to their activity in forming acid. One per cent. of a whey starter made from one culture was sufficient, while it requires three per cent. of another. The *bulgaricus* starters could not be seen to have any effect on the formation of the eyes or interfere with the flavor or texture. It is believed that the proper use of *bulgaricus* starters will go far towards making a more uniform cheese during the summer months and will make it possible to produce good Swiss cheese during the entire year.

[1] Does not ferment raffinose, glycerine, mannite, inulin, starch.

[2] Liquefaction was slow, in some cases occurring only after a number of months.

The Preparation of Dried Cultures: L. A. Rogers, Dairy Division, U. S. Department of Agriculture.

The method of Shackell, consisting essentially in holding the frozen material over sulphuric acid in a high vacuum, is adapted for drying cultures of the lactic acid bacteria, *B. bulgaricus* and other organisms. A chamber was devised in which considerable quantities of powder could be made. The best results are obtained by drying cultures grown on milk concentrated to one half its original volume. Fresh lactic cultures dried by this method curdle milk in twenty hours at 30° when one part of powder is added to 1,000,000 parts of milk. Dried cultures of *B. bulgaricus* curdle milk in twenty hours at 37° when added to the milk in the ratio of 1: 100,000. The activity of a dried culture diminishes more or less rapidly, depending on the conditions under which it is held. The deterioration is less rapid if the moisture content is very low; it is less rapid as the temperature of storage is diminished and is much more rapid in air or oxygen than in an inert gas or in a vacuum.

The Normal Bacteria of Swiss Cheese: E. E. Eldridge and L. A. Rogers, Dairy Division, U. S. Department of Agriculture.

Special media were devised which gave high

counts comparing in a general way with those obtained by dilution in milk. Numerous examinations were made of various cheeses and three domestic cheeses of the Emmenthal type were followed through a nearly complete ripening period. About 1,000 cultures isolated from these cheeses were studied in detail, particularly in relation to their fermentative abilities. It was observed that many of these cultures gave considerable quantities of gas in a sugar-free concentrated whey. It was not possible, however, to separate these cultures beyond three morphological groups, one of which was a long rod, one a short rod and the third a coccus. At the beginning of the ripening the bacterial flora consisted almost entirely of the short rods. The long rods appeared in the early stages of the ripening and increased steadily. The short rods decreased and in each of the three cheeses made up about 50 per cent. of the bacteria at seven or eight weeks, a period corresponding in a general way with the end of the eye formation. Glycerine fermenting cocci appeared in small numbers in each of the cheeses at an age of five or six weeks. At the end of twenty weeks the bacterial flora was composed almost exclusively of the long rods. The essential bacteria of Emmenthal cheese are evidently not ubiquitous. In two widely separated localities cheeses made without inoculation have invariably failed to give the normal fermentation. Cheese made from milk inoculated with a mixture of a large number of pure cultures, or from special culture media inoculated with good cheese, have given uniformly a normal ripening.

Action of a Few Common Butter Organisms upon Casein: Charles W. Brown, Michigan Agricultural College, East Lansing, Mich.

The action of microorganisms upon proteins is looked upon as an aid in identification. If there is an action visible to the sense of sight, liquefaction by that organism is said to be positive, otherwise it is negative. For example, if an organism growing in milk at room temperature for fifteen to thirty days shows no visible digestion, that organism is said to have no action upon casein. This is a mere supposition and in many cases is incorrect. For milk in which such an organism has been growing for several days, if treated with precipitants to remove the unchanged casein, will be found to contain degradation products such as caseoses and peptones. Especially is this true in old milk cultures where the cells of the organisms have died and undergone autolysis, thus liberating an endo-proteolytic enzyme. The power to liquefy casein by liquefiers is either stimulated or retarded to a greater or less degree by four important factors met with in storage butter—addition of salt, diminished supply of free oxygen, low temperature and association with *Bact. lactis acidi.* Now, if we center our observation upon a number of bacteria, found frequently in samples of storage butter, which have no visible action—other than a slight change—upon milk in tubes, within thirty days and make litmus milk agar plates thickly seeded with the organism under observation, we will observe several different pictures presenting themselves. (1) Some of the organisms produce a gradual clearing, noticeable after seven to fifteen days, due to a slow digestion of the casein. (2) If after incubating twenty-four hours at 20° C. the plates are inoculated with *Bact. lactis acidi* by making a stroke on the surface, we see in the case of some of the organisms a rather abundant growth of the lactic with acid production, curdling of the milk in immediate vicinity of the lactic, surrounded by a clear zone and, surrounding the clear zone, a more copious growth of the organism. (3) The same picture with the exception that the growth of the organism is not stimulated. (4) Growth of the lactic about normal, no acidity, the milk in the immediate vicinity of the lactic completely dissolved and surrounded by a more copious growth of the organism. (5) The same except no stimulated growth of the organism. (6) Growth of lactic normal, no acidity, no clearing, but a stimulated growth of the organism. (7) The same except the growth of the organism is not stimulated. (8) Retarded or prevented growth of lactic, no acidity, no digestion and no stimulated growth. A different picture may present itself, if the litmus milk agar plate of the organism is incubated for three to five days before stroking the surface with the lactic, in that the growth of the lactic may be inhibited and that no digestion may occur. Again, if the supply of free oxygen is diminished both before and after stroking the surface with lactic, or if salt is added, or if a lower temperature is used for incubation, different results will be obtained. These organisms, generally spoken of as non-liquefiers, influenced in their action upon casein by different factors can not be overlooked as agents in the degradation of casein in both storage butter and ripening cheese.

A. Parker Hitchens,
Secretary

(To be continued)

SCIENCE

FRIDAY, SEPTEMBER 19, 1913

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

CONTINUITY[1]

Natura non vincitur nisi parendo.

FIRST let me lament the catastrophe which has led to my occupying the chair here in this city. Sir William White was a personal friend of many here present, and I would that the citizens of Birmingham could have become acquainted with his attractive personality, and heard at first hand of the strenuous work which he accomplished in carrying out the behests of the empire in the construction of its first line of defence.

Although a British Association address is hardly an annual stocktaking, it would be improper to begin this year of office without referring to three more of our losses:—One that cultured gentleman, amateur of science in the best sense, who was chosen to preside over our jubilee meeting at York thirty-two years ago. Sir John Lubbock, first Baron Avebury, cultivated science in a spirit of pure enjoyment, treating it almost as one of the arts; and he devoted social and political energy to the welfare of the multitude of his fellows less fortunately situated than himself.

Through the untimely death of Sir George Darwin the world has lost a mathematical astronomer whose work on the tides and allied phenomena is a monument of power and achievement. So recently as our visit to South Africa he occupied the presidential chair.

By the third of our major losses, I mean the death of that brilliant mathematician of a neighboring nation who took so com-

[1] Address of the president of the British Association. Read at Birmingham, September 10, 1913.

prehensive and philosophic a grasp of the intricacies of physics, and whose eloquent though sceptical exposition of our laws and processes, and of the modifications entailed in them by recent advances, will be sure to attract still more widespread attention among all to whom the rather abstruse subject-matter is sufficiently familiar. I can not say that I find myself in agreement with all that Henri Poincaré wrote or spoke in the domain of physics, but no physicist can help being interested in his mode of presentation, and I may have occasion to refer, in passing, to some of the topics with which he dealt.

And now, eliminating from our purview, as is always necessary, a great mass of human activity, and limiting ourselves to a scrutiny on the side of pure science alone, let us ask what, in the main, is the characteristic of the promising though perturbing period in which we live. Different persons would give different answers, but the answer I venture to give is—rapid progress, combined with fundamental scepticism.

Rapid progress was not characteristic of the latter half of the nineteenth century—at least not in physics. Fine solid dynamical foundations were laid, and the edifice of knowledge was consolidated; but wholly fresh ground was not being opened up, and totally new buildings were not expected.

In many cases the student was led to believe that the main facts of nature were all known, that the chances of any great discovery being made by experiment were vanishingly small, and that therefore the experimentalist's work consisted in deciding between rival theories, or in finding some small residual effect, which might add a more or less important detail to the theory.—Schuster.

With the realization of predicted ether waves in 1888, the discovery of X-rays in 1895, spontaneous radioactivity in 1896, and the isolation of the electron in 1898, expectation of further achievement became vivid; and novelties, experimental, theoretical and speculative, have been showered upon us ever since this century began. That is why I speak of rapid progress.

Of the progress I shall say little—there must always be some uncertainty as to which particular achievement permanently contributes to it; but I will speak about the fundamental scepticism.

Let me hasten to explain that I do not mean the well-worn and almost antique theme of theological scepticism: that controversy is practically in abeyance just now. At any rate the major conflict is suspended; the forts behind which the enemy has retreated do not invite attack; the territory now occupied by him is little more than his legitimate province. It is the scientific allies, now, who are waging a more or less invigorating conflict among themselves, with philosophers joining in. Meanwhile the ancient foe is biding his time and hoping that from the struggle something will emerge of benefit to himself. Some positions, he feels, were too hastily abandoned and may perhaps be retrieved; or, to put it without metaphor, it seems possible that a few of the things prematurely denied, because asserted on inconclusive evidence, may after all, in some form or other, have really happened. Thus the old theological bitterness is mitigated, and a temporizing policy is either advocated or instinctively adopted.

To illustrate the nature of the fundamental scientific or philosophic controversies to which I do refer, would require almost as many addresses as there are sections of the British Association, or at any rate as many as there are chief cities in Australia; and perhaps my successor in the chair will continue the theme; but, to exhibit my meaning very briefly, I may cite the kind of dominating controversies now extant, employing as far as possible

only a single word in each case so as to emphasize the necessary brevity and insufficiency of the reference.

In physiology the conflict ranges round *vitalism*. (My immediate predecessor dealt with the subject at Dundee.)

In chemistry the debate concerns *atomic structure*. (My penultimate predecessor is well aware of pugnacity in that region.)

In biology the dispute is on the laws of *inheritance*. (My successor is sure to deal with this subject; probably in a way not deficient in liveliness.)

And besides these major controversies, debate is active in other sections:

In education, *curricula* generally are being overhauled or fundamentally criticized, and revolutionary ideas are promulgated concerning the advantages of freedom for infants.

In economic and political science, or sociology, what is there that is not under discussion? Not property alone, nor land alone, but everything,—back to the garden of Eden and the interrelations of men and women.

Lastly, in the vast group of mathematical and physical sciences, "slurred over rather than summed up as Section A," present-day scepticism concerns what, if I had to express it in one word, I should call *continuity*. The full meaning of this term will hardly be intelligible without explanation, and I shall discuss it presently.

Still more fundamental and deep-rooted than any of these sectional debates, however, a critical examination of scientific foundations generally is going on; and a kind of philosophic scepticism is in the ascendant, resulting in a mistrust of purely intellectual processes and in a recognition of the limited scope of science.

For science is undoubtedly an affair of the intellect, it examines everything in the cold light of reason; and that is its strength. It is a commonplace to say that science must have no likes or dislikes, must aim only at truth; or as Bertrand Russell well puts it:

> The kernel of the scientific outlook is the refusal to regard our own desires, tastes and interests as affording a key to the understanding of the world.

This exclusive single-eyed attitude of science is its strength; but, if pressed beyond the positive region of usefulness into a field of dogmatic negation and philosophizing, it becomes also its weakness. For the nature of man is a large thing, and intellect is only a part of it: a recent part too, which therefore necessarily, though not consciously, suffers from some of the defects of newness and crudity, and should refrain from imagining itself the whole—perhaps it is not even the best part—of human nature.

The fact is that some of the best things are, by abstraction, excluded from science, though not from literature and poetry; hence perhaps an ancient mistrust or dislike of science, typified by the Promethean legend. Science is systematized and *metrical* knowledge, and in regions where measurement can not be applied it has small scope; or, as Mr. Balfour said the other day at the opening of a new wing of the National Physical Laboratory:

> Science depends on measurement, and things not measurable are therefore excluded, or tend to be excluded, from its attention. But life and beauty and happiness are not measurable.

And then characteristically he adds:

> If there could be a unit of happiness, politics might begin to be scientific.

Emotion and intuition and instinct are immensely older than science, and in a comprehensive survey of existence they can not be ignored. Scientific men may

rightly neglect them, in order to do their proper work, but philosophers can not.

So philosophers have begun to question some of the larger generalizations of science, and to ask whether in the effort to be universal and comprehensive we have not extended our laboratory inductions too far. The conservation of energy, for instance—is it always and everywhere valid; or may it under some conditions be disobeyed? It would seem as if the second law of thermodynamics must be somewhere disobeyed—at least if the age of the universe is both ways infinite—else the final consummation would have already arrived.

Not by philosophers only, but by scientific men also, ancient postulates are being pulled up by the roots. Physicists and mathematicians are beginning to consider whether the long known and well-established laws of mechanics hold true everywhere and always, or whether the Newtonian scheme must be replaced by something more modern, something to which Newton's laws of motion are but an approximation.

Indeed a whole system of non-Newtonian mechanics has been devised, having as its foundation the recently discovered changes which must occur in bodies moving at speeds nearly comparable with that of light. It turns out in fact that both shape and mass are functions of velocity. As the speed increases the mass increases and the shape is distorted, though under ordinary conditions only to an infinitesimal extent.

So far I agree; I agree with the statement of fact; but I do not consider it so revolutionary as to overturn Newtonian mechanics. After all, a variation of mass is familiar enough, and it would be a great mistake to say that Newton's second law breaks down merely because mass is not constant. A raindrop is an example of variable mass; or the earth may be, by reason of meteoric dust; or the sun, by reason of radio-activity; or a locomotive, by reason of the emission of steam. In fact, variable masses are the commonest, for friction may abrade any moving body to a microscopic extent.

That mass is constant is only an approximation. That mass is equal to ratio of force and acceleration is a definition, and can be absolutely accurate. It holds perfectly even for an electron with a speed near that of light; and it is by means of Newton's second law that the variation of mass with velocity has been experimentally observed and compared with theory.

I urge that we remain with, or go back to, Newton. I see no reason against retaining all Newton's laws, discarding nothing, but supplementing them in the light of further knowledge.

Even the laws of geometry have been overhauled, and Euclidean geometry is seen to be but a special case of more fundamental generalizations. How far they apply to existing space, and how far time is a reality or an illusion, and whether it can in any sense depend on the motion or the position of an observer: all these things in some form or other are discussed.

The conservation of matter also, that main-mast of nineteenth century chemistry, and the existence of the ether of space, that sheet-anchor of nineteenth century physics—do they not sometimes seem to be going by the board?

Professor Schuster, in his American lectures, commented on the modern receptive attitude as follows:-

> The state of plasticity and flux—a healthy state, in my opinion—in which scientific thought of the present day adapts itself to almost any novelty, is illustrated by the complacency with which the most cherished tenets of our fathers are being abandoned. Though it was never an article of orthodox faith that chemical elements were immutable and would not some day be resolved into

simpler constituents, yet the conservation of mass seemed to lie at the very foundation of creation. But nowadays the student finds little to disturb him, perhaps too little, in the idea that mass changes with velocity; and he does not always realize the full meaning of the consequences which are involved.

This readiness to accept and incorporate new facts into the scheme of physics may have led to perhaps an undue amount of scientific scepticism, in order to right the balance.

But a still deeper variety of comprehensive scepticism exists, and it is argued that all our laws of nature, so laboriously ascertained and carefully formulated, are but conventions after all, not truths: that we have no faculty for ascertaining real truth, that our intelligence was not evolved for any such academic purpose; that all we can do is to express things in a form convenient for present purposes and employ that mode of expression as a tentative and pragmatically useful explanation.

Even *explanation,* however, has been discarded as too ambitious by some men of science, who claim only the power to describe. They not only emphasize the *how* rather than the *why*—as is in some sort inevitable, since explanations are never ultimate—but are satisfied with very abstract propositions, and regard mathematical equations as preferable to, because safer than, mechanical analogies or models.

To use an acute and familiar expression of Gustav Kirchhoff, it is the object of science to *describe* natural phenomena, not to *explain* them. When we have expressed by an equation the correct relationship between different natural phenomena we have gone as far as we safely can, and if we go beyond we are entering on purely speculative ground.

But the modes of statement preferred by those who distrust our power of going correctly into detail are far from satisfactory. Professor Schuster describes and comments on them thus:

Vagueness, which used to be recognized as our great enemy, is now being enshrined as an idol to be worshipped. We may never know what constitutes atoms, or what is the real structure of the ether; why trouble, therefore, it is said, to find out more about them. Is it not safer, on the contrary, to confine ourselves to a general talk on entropy, luminiferous vectors and undefined symbols expressing vaguely certain physical relationships? What really lies at the bottom of the great fascination which these new doctrines exert on the present generation is sheer cowardice; the fear of having its errors brought home to it. . . .

I believe this doctrine to be fatal to a healthy development of science. Granting the impossibility of penetrating beyond the most superficial layers of observed phenomena, I would put the distinction between the two attitudes of mind in this way: One glorifies our ignorance, while the other accepts it as a regrettable necessity.

In further illustration of the modern sceptical attitude, I quote from Poincaré:

Principles are conventions and definitions in disguise. They are, however, deduced from experimental laws, and these laws have, so to speak, been erected into principles to which our mind attributes an absolute value. . . .

The fundamental propositions of geometry, for instance Euclid's postulate, are only conventions; and it is quite as unreasonable to ask if they are true or false as to ask if the metric system is true or false. Only, these conventions are convenient. . . .

Whether the ether exists or not matters little—let us leave that to the metaphysicians; what is essential for us is that everything happens as if it existed, and that this hypothesis is found to be suitable for the explanation of phenomena. After all, have we any other reason for believing in the existence of material objects? That, too, is only a convenient hypothesis.

As an antidote against over-pressing these utterances I quote from Sir J. Larmor's preface:

There has been of late a growing trend of opinion, prompted in part by general philosophical views, in the direction that the theoretical constructions of physical science are largely factitious, that instead of presenting a valid image of the relations of things on which further progress can be based, they are still little better than a mirage. . . .

The best method of abating this scepticism is to become acquainted with the real scope and modes of application of conceptions which, in the popular language of superficial exposition—and even in the unguarded and playful paradox of their authors, intended only for the instructed eye —often look bizarre enough.

One thing is very notable, that it is closer and more exact knowledge that has led to the kind of scientific scepticism now referred to; and that the simple laws on which we used to be working were thus simple and discoverable because the full complexity of existence was tempered to our ken by the roughness of our means of observation.

Kepler's laws are not accurately true, and if he had had before him all the data now available he could hardly have discovered them. A planet does not really move in an ellipse but in a kind of hypocycloid, and not accurately in that either.

So it is also with Boyle's law, and the other simple laws in physical chemistry. Even Van der Waals's generalization of Boyle's law is only a further approximation.

In most parts of physics simplicity has sooner or later to give place to complexity: though certainly I urge that the simple laws were true, and are still true, as far as they go, their inaccuracy being only detected by further real discovery. The reason they are departed from becomes known to us; the law is not really disobeyed, but is modified through the action of a known additional cause. Hence it is all in the direction of progress.

It is only fair to quote Poincaré again, now that I am able in the main to agree with him:

Take for instance the laws of reflection. Fresnel established them by a simple and attractive theory which experiment seemed to confirm. Subsequently, more accurate researches have shown that this verification was but approximate; traces of elliptic polarization were detected everywhere. But it is owing to the first approximation that the cause of these anomalies was found, in the existence of a transition layer; and all the essentials of Fresnel's theory have remained. We can not help reflecting that all these relations would never have been noted if there had been doubt in the first place as to the complexity of the objects they connect. Long ago it was said: If Tycho had had instruments ten times as precise, we would never have had a Kepler, or a Newton, or astronomy. It is a misfortune for a science to be born too late, when the means of observation have become too perfect. That is what is happening at this moment with respect to physical chemistry; the founders are hampered in their general grasp by third and fourth decimal places; happily they are men of robust faith. As we get to know the properties of matter better we see that continuity reigns. . . . It would be difficult to justify [the belief in continuity] by apodeictic reasoning, but without [it] all science would be impossible.

Here he touches on my own theme, *continuity;* for, if we had to summarize the main trend of physical controversy at present, I feel inclined to urge that it largely turns on the question as to which way ultimate victory lies in the fight between continuity and discontinuity.

On the surface of nature at first we see discontinuity; objects detached and countable. Then we realize the air and other media, and so emphasize continuity and flowing quantities. Then we detect atoms and numerical properties, and discontinuity once more makes its appearance. Then we invent the ether and are impressed with continuity again. But this is not likely to be the end; and what the ultimate end will be, or whether there is an ultimate end, is a question difficult to answer.

The modern tendency is to emphasize the discontinuous or atomic character of everything. Matter has long been atomic, in the same sense as anthropology is atomic; the unit of matter is the atom, as the unit of humanity is the individual. Whether men or women or children—they can be counted

as so many "souls." And atoms of matter can be counted too.

Certainly however there is an illusion of continuity. We recognize it in the case of water. It appears to be a continuous medium, and yet it is certainly molecular. It is made continuous again, in a sense, by the ether postulated in its pores; for the ether is essentially continuous. Though Osborne Reynolds, it is true, invented a discontinuous or granular ether, on the analogy of the seashore. The sands of the sea, the hairs of the head, the descendants of a patriarch, are typical instances of numerable, or rather of innumerable, things. The difficulty of enumerating them is not that there is nothing to count, but merely that the things to be counted are very numerous. So are the atoms in a drop of water—they outnumber the drops in an Atlantic Ocean—and, during the briefest time of stating their number, fifty millions or so may have evaporated; but they are as easy to count as the grains of sand on a shore.

The process of counting is evidently a process applicable to discontinuities, *i. e.*, to things with natural units; you can count apples and coins, and days and years, and people and atoms. To apply number to a continuum you must first cut it up into artificial units; and you are always left with incommensurable fractions. Thus only is it that you can deal numerically with such continuous phenomena as the warmth of a room, the speed of a bird, the pull of a rope or the strength of a current.

But how, it may be asked, does discontinuity apply to number? The natural numbers, 1, 2, 3, etc., are discontinuous enough, but there are fractions to fill up the interstices; how do we know that they are not really connected by these fractions, and so made continuous again?

(By number I always mean commensurable number; incommensurables are not numbers: they are just what can not be expressed in numbers. The square root of 2 is not a number, though it can be readily indicated by a length. Incommensurables are usual in physics and are frequent in geometry; the conceptions of geometry are essentially continuous. It is clear, as Poincaré says, that "if the points whose coordinates are commensurable were alone regarded as real, the in-circle of a square and the diagonal of the square would not intersect, since the coordinates of the points of intersection are incommensurable.")

I want to explain how commensurable fractions do not connect up numbers, nor remove their discontinuity in the least. The divisions on a foot rule, divided as closely as you please, represent commensurable fractions, but they represent none of the length. No matter how numerous they are, all the length lies between them; the divisions are mere partitions and have consumed none of it; nor do they connect up with each other, they are essentially discontinuous. The interspaces are infinitely more extensive than the barriers which partition them off from one another; they are like a row of compartments with infinitely thin walls. All the incommensurables lie in the interspaces; the compartments are full of them, and they are thus infinitely more numerous than the numerically expressible magnitudes. Take any point of the scale at random, that point will certainly lie in an interspace: it will not lie on a division, for the chances are infinity to 1 against it.

Accordingly incommensurable quantities are the rule in physics. Decimals do not in practise terminate or circulate, in other words vulgar fractions do not accidentally occur in any measurements, for this would mean infinite accuracy. We proceed to as

many places of decimals as correspond to the order of accuracy aimed at.

Whenever, then, a commensurable number is really associated with any natural phenomenon, there is necessarily a noteworthy circumstance involved in the fact, and it means something quite definite and ultimately ascertainable. Every discontinuity that can be detected and counted is an addition to knowledge. It not only means the discovery of natural units instead of being dependent on artificial ones, but it throws light also on the nature of phenomena themselves.

For instance:

The ratio between the velocity of light and the inverted square root of the product of the electric and magnetic constants was discovered by Clerk Maxwell to be 1; and a new volume of physics was by that discovery opened.

Dalton found that chemical combination occurred between quantities of different fractional numbers; and the atomic theory of matter sprang into substantial though at first infantile existence.

The hypothesis of Prout, which in some modified form seems likely to be substantiated, is that all atomic weights are commensurable numbers; in which case there must be a natural fundamental unit underlying, and in definite groups composing, the atoms of every form of matter.

The small number of degrees of freedom of a molecule, and the subdivision of its total energy into equal parts corresponding thereto, is a theme not indeed without difficulty but full of importance. It is responsible for the suggestion that energy too may be atomic!

Mendelejeff's series again, or the detection of a natural grouping of atomic weights in families of seven, is another example of the significance of number.

Electricity was found by Faraday to be numerically connected with quantity of matter; and the atom of electricity began its hesitating but now brilliant career.

Electricity itself—*i. e.*, electric charge—strangely enough has proved itself to be atomic. There is a natural unit of electric charge, as suspected by Faraday and Maxwell and named by Johnstone Stoney. Some of the electron's visible effects were studied by Crookes in a vacuum; and its weighing and measuring by J. J. Thomson were announced to the British Association meeting at Dover in 1899, a fitting prelude to the twentieth century.

An electron is the natural unit of negative electricity, and it may not be long before the natural unit of positive electricity is found too. But concerning the nature of the positive unit there is at present some division into opposite camps. One school prefers to regard the unit of positive electricity as a homogeneous sphere, the size of an atom, in which electrons revolve in simple harmonic orbits and constitute nearly the whole effective mass. Another school, while appreciative of the simplicity and ingenuity and beauty of the details of this conception, and the skill with which it has been worked out, yet thinks the evidence more in favor of a minute central positive nucleus, or nucleus-group, of practically atomic mass; with electrons, larger—*i. e.*, less concentrated—and therefore less massive than itself, revolving round it in astronomical orbits. While from yet another point of view it is insisted that positive and negative electrons can only differ skew-symmetrically, one being like the image of the other in a mirror, and that the mode in which they are grouped to form an atom remains for future discovery. But no one doubts that electricity is ultimately atomic.

Even magnetism has been suspected of being atomic, and its hypothetical unit has

been named in advance the magneton: but I confess that here I have not been shaken out of the conservative view.

We may express all this as an invasion of number into unsuspected regions.

Biology may be said to be becoming atomic. It has long had natural units in the shape of cells and nuclei, and some discontinuity represented by body-boundaries and cell-walls; but now, in its laws of heredity as studied by Mendel, number and discontinuity are strikingly apparent among the reproductive cells, and the varieties of offspring admit of numerical specification and prediction to a surprising extent: while modification by continuous variation, which seemed to be of the essence of Darwinism, gives place to, or at least is accompanied by, mutation, with finite and considerable and in appearance discontinuous change.

So far from nature not making jumps, it becomes doubtful if she does anything else. Her hitherto placid course, more closely examined, seems to look like a kind of steeplechase.

Yet undoubtedly continuity is the backbone of evolution, as taught by all biologists—no artificial boundaries or demarcations between species—a continuous chain of heredity from far below the amœba up to man. Actual continuity of undying germplasm, running through all generations, is taught likewise; though a strange discontinuity between this persistent element and its successive accessory body-plasms—a discontinuity which would convert individual organisms into mere temporary accretions or excretions, with no power of influencing or conveying experience to their generating cells—is advocated by one school.

Discontinuity does not fail to exercise fascination even in pure mathematics. Curves are invented which have no tangent or differential coefficient, curves which consist of a succession of dots or of twists; and the theory of commensurable numbers seems to be exerting a dominance over philosophic mathematical thought as well as over physical problems.

And not only these fairly accepted results are prominent, but some more difficult and unexpected theses in the same direction are being propounded, and the atomic character of energy is advocated. We had hoped to be honored by the presence of Professor Planck, whose theory of the *quantum,* or indivisible unit or atom of energy, excites the greatest interest, and by some is thought to hold the field.

Then again radiation is showing signs of becoming atomic or discontinuous. The corpuscular theory of radiation is by no means so dead as in my youth we thought it was. Some radiation is certainly corpuscular, and even the etherial kind shows indications, which may be misleading, that it is spotty, or locally concentrated into points, as if the wave-front consisted of detached specks or patches; or, as J. J. Thomson says, "the wave-front must be more analogous to bright specks on a dark ground than to a uniformly illuminated surface," thus suggesting that the ether may be fibrous in structure, and that a wave runs along lines of electric force, as the genius of Faraday surmised might be possible, in his "Thoughts on Ray Vibrations." Indeed Newton guessed something of the same kind, I fancy, when he superposed ether-pulses on his corpuscles.

Whatever be the truth in this matter, a discussion on radiation, of extreme weight and interest, though likewise of great profundity and technicality, is expected on Friday in Section A. We welcome Professor Lorentz, Dr. Arrhenius, Professor Langevin, Professor Pringsheim and others, some of whom have been specially invited to England because of the impor-

tant contributions which they have made to the subject-matter of this discussion.

Why is so much importance attached to radiation? Because it is the best-known and longest-studied link between matter and ether, and the only property we are acquainted with that affects the unmodified great mass of ether alone. Electricity and magnetism are associated with the modifications or singularities called electrons: most phenomena are connected still more directly with matter. Radiation, however, though excited by an accelerated electron, is subsequently let loose in the ether of space, and travels as a definite thing at a measurable and constant pace—a pace independent of everything so long as the ether is free, unmodified and unloaded by matter. Hence radiation has much to teach us, and we have much to learn concerning its nature.

How far can the analogy of granular, corpuscular, countable, atomic or discontinuous things be pressed? There are those who think it can be pressed very far. But to avoid misunderstanding let me state, for what it may be worth, that I myself am an upholder of *ultimate* continuity, and a fervent believer in the ether of space.

We have already learned something about the ether; and although there may be almost as many varieties of opinion as there are people qualified to form one, in my view we have learned as follows:

The ether is the universal connecting medium which binds the universe together, and makes it a coherent whole instead of a chaotic collection of independent isolated fragments. It is the vehicle of transmission of all manner of force, from gravitation down to cohesion and chemical affinity; it is therefore the storehouse of potential energy.

Matter moves, but ether is strained.

What we call elasticity of matter is only the result of an alteration of configuration due to movement and readjustment of particles, but all the strain and stress are in the ether. The ether itself does not move, that is to say it does not move in the sense of locomotion, though it is probably in a violent state of rotational or turbulent motion in its smallest parts; and to that motion its exceeding rigidity is due.

As to its density, it must be far greater than that of any form of matter, millions of times denser than lead or platinum. Yet matter moves through it with perfect freedom, without any friction or viscosity. There is nothing paradoxical in this: viscosity is not a function of density; the two are not necessarily connected. When a solid moves through an alien fluid it is true that it acquires a spurious or apparent extra inertia from the fluid it displaces; but in the case of matter and ether, not only is even the densest matter excessively porous and discontinuous, with vast interspaces in and among the atoms, but the constitution of matter is such that there appears to be no displacement in the ordinary sense at all; the ether is itself so modified as to *constitute* the matter in some way. Of course that portion moves, its inertia is what we observe, and its amount depends on the potential energy in its associated electric field, but the motion is not like that of a foreign body, it is that of some inherent and merely individualized portion of the stuff itself. Certain it is that the ether exhibits no trace of viscosity.[2]

Matter in motion, ether under strain, constitute the fundamental concrete things we have to do with in physics. The first

[2] For details of my experiment on this subject see *Phil Trans. Roy. Soc.* for 1893 and 1897; or a very abbreviated reference to it, and to the other matters above mentioned, in my small book, "The Ether of Space."

pair represent kinetic energy, the second potential energy; and all the activities of the material universe are represented by alternations from one of these forms to the other.

Whenever this transference and transformation of energy occur, work is done, and some effect is produced, but the energy is never diminished in quantity: it is merely passed on from one body to another, always from ether to matter or *vice versa* —except in the case of radiation, which simulates matter—and from one form to another.

The forms of energy can be classified as either a translation, a rotation or a vibration of pieces of matter of different sizes, from stars and planets down to atoms and electrons; or else an etherial strain which in various different ways is manifested by the behavior of such masses of matter as appeal to our senses.[8]

Some of the facts responsible for the suggestion that energy is atomic seem to me to depend on the discontinuous nature of the structure of a material atom, and on the high velocity of its constituent particles. The apparently discontinuous emission of radiation is, I believe, due to features in the real discontinuity of matter. Disturbances inside an atom appear to be essentially catastrophic; a portion is liable to be ejected with violence. There appears to be a critical velocity below which ejection does not take place; and, when it does, there also occurs a sudden rearrangement of parts which is presumably responsible for some perceptible etherial radiation. Hence it is, I suppose, that radiation comes off in gushes or bursts; and hence it appears to consist of indivisible units. The occasional phenomenon of new stars, as compared with the steady orbital motion of the millions of recognized bodies, may be suggested as an astronomical analogue.

[8] See, in the *Philosophical Magazine* for 1879, my article on "A Classification of the Forms of Energy."

The hypothesis of *quanta* was devised to reconcile the law that the energy of a group of colliding molecules must in the long run be equally shared among all their degrees of freedom, with the observed fact that the energy is really shared into only a small number of equal parts. For if vibration-possibilities have to be taken into account, the number of degrees of molecular freedom must be very large, and energy shared among them ought soon to be all frittered away; whereas it is not. Hence the idea is suggested that minor degrees of freedom are initially excluded from sharing the energy, because they can not be supplied with less than one atom of it.

I should prefer to express the fact by saying that the ordinary encounters of molecules are not of a kind able to excite atomic vibrations, or in any way to disturb the ether. Spectroscopic or luminous vibrations of an atom are excited only by an exceptionally violent kind of collision, which may be spoken of as chemical clash; the ordinary molecular orbital encounters, always going on at the rate of millions a second, are ineffective in that respect, except in the case of phosphorescent or luminescent substances. That common molecular deflexions *are* ineffective is certain, else all the energy would be dissipated or transferred from matter into the ether; and the reasonableness of their radiative inefficiency is not far to seek, when we consider the comparatively leisurely character of molecular movements, at speeds comparable with the velocity of sound. Admittedly, however, the effective rigidity of molecules must be complete, otherwise the sharing of energy must ultimately occur. They do not seem able

to be set vibrating by anything less than a certain minimum stimulus; and that is the basis for the theory of *quanta*.

Quantitative applications of Planck's theory, to elucidate the otherwise shaky stability of the astronomically constituted atom, have been made; and the agreement between results so calculated and those observed, including a determination of series of spectrum lines, is very remarkable. One of the latest contributions to this subject is a paper by Dr. Bohr in the *Philosophical Magazine* for July this year.

To show that I am not exaggerating the modern tendency towards discontinuity, I quote, from M. Poincaré's "Dernières Pensées," a proposition which he announces in italics as representing a form of Professor Planck's view of which he apparently approves:

A physical system is susceptible of a finite number only of distinct conditions; it jumps from one of these conditions to another without passing through a continuous series of intermediate conditions.

Also this from Sir Joseph Larmor's preface to Poincaré's "Science and Hypothesis":

Still more recently it has been found that the good Bishop Berkeley's logical jibes against the Newtonian ideas of fluxions and limiting ratios can not be adequately appeased in the rigorous mathematical conscience, until our apparent continuities are resolved mentally into discrete aggregates which we only partially apprehend. The irresistible impulse to atomize everything thus proves to be not merely a disease of the physicist: a deeper origin, in the nature of knowledge itself, is suggested.

One very valid excuse for this prevalent attitude is the astonishing progress that has been made in actually seeing or almost seeing the molecules, and studying their arrangement and distribution.

The laws of gases have been found to apply to emulsions and to fine powders in suspension, of which the Brownian movement has long been known. This movement is caused by the orthodox molecular bombardment, and its average amplitude exactly represents the theoretical mean free path calculated from the "molecular weight" of the relatively gigantic particles. The behavior of these microscopically visible masses corresponds closely and quantitatively with what could be predicted for them as fearfully heavy atoms, on the kinetic theory of gases; they may indeed be said to constitute a gas with a gram-molecule as high as 200,000 tons; and, what is rather important as well as interesting, they tend visibly to verify the law of equipartition of energy even in so extreme a case, when that law is properly stated and applied.

Still more remarkable, the application of X-rays to display the arrangement of molecules in crystals, and ultimately the arrangement of atoms in molecules, as initiated by Professor Laue with Drs. Friedrich and Knipping, and continued by Professor Bragg and his son and by Dr. Tutton, constitute a series of researches of high interest and promise. By this means many of the theoretical anticipations of our countryman, Mr. William Barlow, and—working with him—Professor Pope, as well as of those distinguished crystallographers von Groth and von Fedorow, have been confirmed in a striking way. These brilliant researches, which seem likely to constitute a branch of physics in themselves, and which are being continued by Messrs. Moseley and C. G. Darwin, and by Mr. Keene and others, may be called an apotheosis of the atomic theory of matter.

One other controversial topic I shall touch upon in the domain of physics, though I shall touch upon it lightly, for it is not a matter for easy reference as yet. If the *principle of relativity* in an extreme

sense establishes itself, it seems as if even time would become discontinuous and be supplied in atoms, as money is doled out in pence or centimes instead of continuously—in which case our customary existence will turn out to be no more really continuous than the events on a kinematograph screen—while that great agent of continuity, the ether of space, will be relegated to the museum of historical curiosities.

In that case differential equations will cease to represent the facts of nature, they will have to be replaced by finite differences, and the most fundamental revolution since Newton will be inaugurated.

Now in all the debatable matters of which I have indicated possibilities I want to urge a conservative attitude. I accept the new experimental results on which some of these theories—such as the principle of relativity—are based, and am profoundly interested in them, but I do not feel that they are so revolutionary as their propounders think. I see a way to retain the old and yet embrace the new, and I urge moderation in the uprooting and removal of landmarks.

And of these the chief is continuity. I can not imagine the exertion of mechanical force across empty space, no matter how minute; a continuous medium seems to me essential. I can not admit discontinuity in either space or time, nor can I imagine any sort of experiment which would justify such a hypothesis. For surely we must realize that we know nothing experimental of either space or time, we can not modify them in any way. We make experiments on bodies, and only on bodies, using "body" as an exceedingly general term.

We have no reason to postulate anything but continuity for space and time. We cut them up into conventional units for convenience' sake, and those units we can count; but there is really nothing atomic or countable about the things themselves. We can count the rotations of the earth, or the revolutions of an electron, or the vibrations of a pendulum, or the waves of light. All these are concrete and tractable physical entities; but space and time are ultimate data, abstractions based on experience. We know them through motion, and through motion only, and motion is essentially continuous. We ought clearly to discriminate between things themselves and our mode of measuring them. Our measures and perceptions may be affected by all manner of incidental and trivial causes, and we may get confused or hampered by our own movement; but there need be no such complication in things themselves, any more than a landscape is distorted by looking at it through an irregular window-pane or from a traveling coach. It is an ancient and discarded fable that complications introduced by the motion of an observer are real complications belonging to the outer universe.

Very well, then, what about the ether, is that in the same predicament? Is that an abstraction, or a mere convention, or is it a concrete physical entity on which we can experiment?

Now it has to be freely admitted that it is exceedingly difficult to make experiments on the ether. It does not appeal to sense, and we know no means of getting hold of it. The one thing we know metrical about it is the velocity with which it can transmit transverse waves. That is clear and definite, and thereby to my judgment it proves itself a physical agent; not indeed tangible or sensible, but yet concretely real.

But it does elude our laboratory grasp. If we rapidly move matter through it, hoping to grip it and move it too, we fail: there is no mechanical connection. And even if we experiment on light we fail too. So long as transparent matter is moving

relatively to us, light can be affected inside that matter; but when matter is relatively stationary to matter nothing observable takes place, however fast things may be moving, so long as they move together.

Hence arises the idea that motion with respect to ether is meaningless: and the fact that only relative motion of pieces of matter with respect to each other has so far been observed is the foundation of the principle of relativity. It sounds simple enough as thus stated, but in its developments it is an ingenious and complicated doctrine embodying surprising consequences which have been worked out by Professor Einstein and his disciples with consummate ingenuity.

What have I to urge against it? Well, in the first place, it is only in accordance with common sense that no effect of the first order can be observed without relative motion of matter. An ether-stream through our laboratories is optically and electrically undetectable, at least as regards first-order observation; this is clearly explained for general readers in my book, "The Ether of Space," chapter IV. But the principle of relativity says more than that, it says that no effect of any order of magnitude can ever be observed without the relative motion of matter.

The truth underlying this doctrine is that absolute motion without reference to *anything* is unmeaning. But the narrowing down of "anything" to mean any piece of matter is illegitimate. The nearest approach to absolute motion that we can physically imagine is motion through or with respect to the ether of space. It is natural to assume that the ether is on the whole stationary and to use it as a standard of rest; in that sense motion with reference to it may be called absolute, but in no other sense.

The principle of relativity claims that we can never ascertain such motion: in other words, it practically or pragmatically denies the existence of the ether. Every one of our scientifically observed motions, it says, are of the same nature as our popularly observed ones, viz., motion of pieces of matter relatively to each other; and that is all that we can ever know. Everything goes on—says the principle of relativity—as if the ether did not exist.

Now the facts are that no motion with reference to the ether alone has ever yet been observed: there are always curious compensating effects which just cancel out the movement-terms and destroy or effectively mask any phenomenon that might otherwise be expected. When matter moves past matter observation can be made; but, even so, no consequent locomotion of ether, outside the actually moving particles, can be detected.

(It is sometimes urged that rotation is a kind of absolute motion that can be detected, even in isolation. It can so be detected, as Newton pointed out; but in cases of rotation matter on one side the axis is moving in the opposite direction to matter on the other side of the axis; hence rotation involves relative material motion, and therefore can be observed.)

To detect motion through ether we must use an etherial process. We may use radiation, and try to compare the speeds of light along or across the motion; or we might try to measure the speed, first with the motion and then against it. But how are we to make the comparison? If the time of emission from a distant source is given by a distant clock, that clock must be observed through a telescope, that is, by a beam of light; which is plainly a compensating process. Or the light from a neighboring source can be sent back to us by a distant mirror; when again there will be compensation. Or the starting of light

from a distant terrestrial source may be telegraphed to us, either with a wire or without; but it is the ether that conveys the message in either case, so again there will be compensation. Electricity, magnetism and light are all effects of the ether.

Use cohesion, then; have a rod stretching from one place to another, and measure that. But cohesion is transmitted by the ether too, if, as believed, it is the universal binding medium. Compensation is likely; compensation can, on the electrical theory of matter, be predicted.

Use some action not dependent on ether, then. Very well, where shall we find it?

To illustrate the difficulty I will quote a sentence from Sir Joseph Larmor's paper before the International Congress of Mathematicians at Cambridge last year:

> If it is correct to say with Maxwell that all radiation is an electrodynamic phenomenon, it is equally correct to say with him that all electrodynamic relations between material bodies are established by the operation, on the molecules of those bodies, of fields of force which are propagated in free space as radiation and in accordance with the laws of radiation, from one body to the other.

The fact is we are living in an epoch of some very comprehensive generalizations. The physical discovery of the twentieth century, so far, is the electrical theory of matter. This is the great new theory of our time; it was referred to, in its philosophical aspect, by Mr. Balfour in his presidential address at Cambridge in 1904. We are too near it to be able to contemplate it properly; it has still to establish itself and to develop in detail, but I anticipate that in some form or other it will prove true.[4]

Here is a briefest possible summary of the first chapter (so to speak) of the electrical theory of matter.

1. Atoms of matter are composed of electrons—of positive and negative electric charges.

2. Atoms are bound together into molecules by chemical affinity, which is intense electrical attraction at ultra-minute distances.

3. Molecules are held together by cohesion, which I for one regard as residual or differential chemical affinity over molecular distances.

4. Magnetism is due to the locomotion of electrons. There is no magnetism without an electric current, atomic or otherwise. There is no electric current without a moving electron.

5. Radiation is generated by every accelerated electron, in amount proportional to the square of its acceleration; and there is no other kind of radiation, except indeed a corpuscular kind; but this depends on the velocity of electrons and therefore again can only be generated by their acceleration.

The theory is bound to have curious consequences; and already it has contributed to some of the uprooting and uncertainty that I speak of. For, if it be true, every material interaction will be electrical, *i. e.*, etherial; and hence arises our difficulty. Every kind of force is transmitted by the ether, and hence, so long as all our apparatus is traveling together at one and the same pace, we have no chance of detecting the motion. That is the strength of the principle of relativity. The changes are not zero, but they cancel each other out of observation.

Many forms of statement of the famous Michelson-Morley experiment are misleading. It is said to prove that the time taken by light to go with the ether stream is the same as that taken to go against or across it. It does not show that. What it shows

[4] For a general introductory account of the electrical theory of matter my Romanes lecture for 1903 (Clarendon Press), may be referred to.

is that the time taken by light to travel to and fro on a measured interval fixed on a rigid block of matter is independent of the aspect of that block with respect to any motion of the earth through space. A definite and most interesting result: but it may be, and often is, interpreted loosely and too widely.

It is interpreted too widely, as I think, when Professor Einstein goes on to assume that no non-relative motion of matter can be ever observed even when *light* is brought into consideration. The relation of light to matter is very curious. The wave front of a progressive wave simulates many of the properties of matter. It has energy, it has momentum, it exerts force, it sustains reaction. It has been described as a portion of the mass of a radiating body—which gives it a curiously and unexpectedly corpuscular "feel." But it has a definite velocity. Its velocity in space relative to the ether is an absolute constant independent of the motion of the source. This would not be true for corpuscular light.

Hence I hold that here is something with which our own motion may theoretically be compared; and I predict that our motion through the ether will some day be detected by help of this very fact—by comparing our speed with that of light: though the old astronomical aberration, which seemed to make the comparison easy, failed to do so quite simply, because it is complicated by the necessity of observing the position of a distant source, in relation to which the earth is moving. If the source and observer are moving together there is no possibility of observing aberration. Nevertheless I maintain that when matter is moving near a beam of light we may be able to detect the motion. For the velocity of light in space is no function of the velocity of the source, nor of matter near it; it is quite unaffected by source or receiver. Once launched it travels in its own way. If we are traveling to meet it, it will be arriving at us more quickly; if we travel away from it, it will reach us with some lag. And observation of the acceleration or retardation is made by aid of Jupiter's satellites. We have there the dial of a clock, to or from which we advance or recede periodically. It gains while we approach it, it loses while we recede from it, it keeps right time when we are stationary or only moving across the line of sight.

But then of course it does not matter whether Jupiter is standing still and we are moving, or *vice versa:* it is a case of relative motion of matter again. So it is if we observe a Doppler effect from the right- and left-hand limbs of the rotating sun. True, and if we are to permit no relative motion of matter we must use a terrestrial source, clamped to the earth as our receiver is. And now we shall observe nothing.

But not because there is nothing to observe. Lag must really occur if we are running away from the light, even though the source is running after us at the same pace, unless we make the assumption—true only for corpuscular light—that the velocity of light is not an absolute thing, but is dependent on the speed of the source. With corpuscular light there is nothing to observe; with wave light there is something, but we can not observe it.

But if the whole solar system is moving through the ether I see no reason why the relative ether drift should not be observed by a differential residual effect in connection with Jupiter's satellites or the right and left limbs of the sun. The effect must be too small to observe without extreme precision, but theoretically it ought to be there. Inasmuch, however, as relative motion of matter with respect to the observer

is involved in these effects, it may be held that the detection of a uniform drift of the solar system in this way is not contrary to the principle of relativity. It is contrary to some statements of that principle; and the cogency of those statements breaks down, I think, whenever they include the velocity of light; because there we really have something absolute (in the only sense in which the term can have a physical meaning) with which we can compare our own motions, when we have learned how.

But in ordinary astronomical translation —translation as of the earth in its orbit— all our instruments, all our standards, the whole contents of our laboratory, are moving at the same rate in the same direction; under those conditions we can not expect to observe anything. Clerk Maxwell went so far as to say that if every particle of matter simultaneously received a graduated blow so as to produce a given constant acceleration all in the same direction, we should be unaware of the fact. He did not then know all that we know about radiation. But apart from that, and limiting ourselves to comparatively slow changes of velocity, our standards will inevitably share whatever change occurs. So far as observation goes, everything will be practically as if no change had occurred at all —though that may not be the truth. All that experiment establishes is that there have so far always been compensations; so that the attempt to observe motion through the ether is being given up as hopeless.

Surely, however, the minute and curious compensations can not be accidental, they must be necessary? Yes, they are necessary; and I want to say why. Suppose the case were one of measuring thermal expansion; and suppose everything had the same temperature and the same expansibility; our standards would contract or expand with everything else, and we could observe nothing; but expansion would occur nevertheless. That is obvious, but the following assertion is not so obvious. If everything in the universe had the same temperature, no matter what that temperature was, nothing would be visible at all; the external world so far as vision went, would not appear to exist. Visibility depends on radiation, on differential radiation. We must have differences to appeal to our senses, they are not constructed for uniformity.

It is the extreme omnipresence and uniformity and universal agency of the ether of space that makes it so difficult to observe. To observe anything you must have differences. If all actions at a distance are conducted at the same rate through the ether, the travel of none of them can be observed. Find something not conveyed by the ether and there is a chance. But then every physical action is transmitted by the ether, and in every case by means of its transverse or radiation-like activity.

Except perhaps gravitation. That may give us a clue some day, but at present we have not been able to detect its speed of transmission at all. No plan has been devised for measuring it. Nothing short of the creation or destruction of matter seems likely to serve; creation or destruction of the gravitational unit, whether it be an atom or an electron or whatever it is. Most likely the unit of weight is an electron, just as the unit of mass is.

OLIVER LODGE

(*To be concluded*)

A SUMMARY OF THE WORK OF THE U. S. FISHERIES MARINE BIOLOGICAL STATION AT BEAUFORT, N. C., DURING 1912

THE laboratory of the Bureau of Fisheries at Beaufort, North Carolina, was open as usual during the summer of 1912, and opened about the middle of June, 1913, to investiga-

tors engaged in the scientific and economic problems of the Bureau and to independent workers. Following is a brief summary of the work of the station and some of the results attained during the year 1912.

The laboratory continued its cooperation with the U. S. Weather Bureau, keeping a daily record of the maximum and minimum temperatures, precipitation (rain and melted snow), etc. These data were forwarded monthly to the Raleigh office.

Greatly needed improvements to grounds and buildings were begun during the year. The library was removed from the crowded laboratory to new quarters on the museum floor, and its contents are being arranged and catalogued according to the system used in the Washington office. A large number of state and other reports were received during the year, scientific works adapted to the needs of the station have been ordered, and an attempt is being made to assemble all publications relating to the fauna and flora of the region. All investigators who have or are publishing such papers are urged to forward separates to the library.

The cultural experiments with the diamond-back terrapin were continued with marked success, and the feasibility of terrapin culture on a commercial basis is practically assured. The 1912 brood numbered over 1,220, more than three times as many as in 1911, and indications are that for the stock of adults on hand the maximum has not been reached. This brood, with those of 1911, 1910 and 1909, makes a total of over 1,900 young terrapin hatched in the enclosures at the laboratory. In the fall of 1911 and spring of 1912, 66 adult terrapin from Texas were purchased, and from the eggs laid by these a sufficient number of young were obtained to begin the experimental work with this form. Professor W. P. Hay had general supervision of much of this work.

It is the purpose of the laboratory to collect all possible data bearing on the fishes of the South Atlantic region, to conduct fish-cultural experiments to show the feasibility of increasing the annual yield by artificial propagation, and to add to knowledge of the life-histories of as many forms as possible. As a basis for this work, the compilation of all existing information on the local fishes has been undertaken. A card catalogue of species and a systematic list with synonymy of published references for the region are practically completed, about 235 species being represented.

In an examination of old collections in the laboratory several examples of a mad-tom, *Schilbeodes gyrinus* (Mitchill), from Lake Mattamuskeet, N. C., were found. This is believed to be the first record south of the Potomac River at Washington, D. C. Two additional species not previously reported from North Carolina were taken during the summer. The first, a galeid-shark, *Hypoprion brevirostris* Poey, represented by two examples, had been reported as far north as Charleston, S. C.; one specimen was 7½ feet long, the largest recorded. A southern sting-ray, *Dasyatis sabina* (Le Sueur), was also taken. This species appears to be quite abundant and has probably been confused heretofore with small examples of some of the other species. An example of *Carcharhinus acronotus* (Poey), the second record for the coast, was also obtained. A fine example of the interesting ray *Mobula olfersi* (Muller & Henle) was presented to the laboratory by Mr. Russell J. Coles.

On July 26, 1912, a beaked whale (*Mesoplodon*) 16 feet long was stranded on Bird Island Shoal in the harbor. The head, tail and one of the pectoral fins were sent to the U. S. National Museum, where Dr. F. W. True found it to be an undescribed species and has since given to it the name *M. mirum*.[1]

The investigators and independent workers have furnished the data on which the following brief summary of their work is based:

Professor W. P. Hay who, during July, August and September, continued his work on the propagation of the diamond-back terrapin, also spent considerable time on the study of the crustacean fauna of the Beaufort region, and began a series of experiments on the artificial propagation of the loggerhead turtle.

[1] *Smithsonian Misc. Coll.*, Vol. 60, No. 25, March 14, 1913.

Early in July a nest of the loggerhead turtle, containing 135 eggs, was found on the ocean beach of Bogue Bank. The eggs were removed to the laboratory and placed in hatching boxes, and 75 young turtles were hatched and retained until winter. The economic value of the loggerhead turtle is at present very small, but the data secured from the experiments at the laboratory will doubtless be useful if an effort is ever made to cultivate more valuable species of sea turtles.

The decapod crustaceans of the Beaufort region were studied some years ago by Dr. H. A. Shore, but pressure of other matters made it impossible for him to complete his report. It is this unfinished work that has been taken up by Professor Hay and is being put in shape for publication.

Dr. H. S. Davis, of the University of Florida, devoted his time largely to studying the life-history of a dimorphic species of *Myxosporidia* occurring in the urinary bladder and ureters of the squeteague, *Cynoscion regalis.* This species occurs in two very different forms (one disporous, the other polysporous) and possesses many characters of great interest, notably a method of reproduction by internal budding hitherto unknown in the *Myxosporidia.* The development of the spores was worked out in detail and has been found to differ in many respects from the published accounts of spore formation in other species. The account of this work will shortly be ready for publication. Observations were made on a number of species of *Myxosporidia* occurring in the gall bladders of sharks and others inhabiting other marine fishes, and a considerable amount of material was preserved for future study.

Dr. J. F. Abbott, of Washington University, St. Louis, Mo., conducted various experiments on the fiddler crab (*Uca*), which abounds in the neighborhood of Beaufort Harbor.

(*a*) The question of the relative permeability of tissues and particularly of gill membranes to pure distilled water is still an open one. *Fundulus heteroclitus* appears to be impermeable to and unaffected by immersion in pure distilled water. From the apparent immunity of the fiddler crab to fresh and distilled water it appears at first that it, like *Fundulus,* offers a similar exception to the rule that animal membranes are freely permeable. It was discovered after prolonged experiment that the crab stores up very small quantities of sea water in its gill chamber, with which it modifies the pure water sufficiently to preserve its life. If the gill chamber be cut away and the cavity washed out, this immunity disappears and the crab succumbs to the effect of the water with an increase of weight (indicating the penetration of water) and a loss of salts (discoverable by titrating the immersing medium for chlorides). If the amount of water be small the crab is able by emitting minute quantities of electrolytes to alter the medium sufficiently to nullify the destructive solvent action of the pure water on the gill-membranes. An account of this portion of the work has been published in the *Biological Bulletin* of the Marine Biological Laboratory at Woods Hole, Mass. (Vol. 24, p. 169, 1912).

(*b*) Other lines of experiment on the nullifying action of one poisonous component of the sea water by another were carried out, leading to results which in general substantiate J. Loeb's hypothesis of balanced solutions as worked out on marine vertebrates.

(*c*) In connection with the storage of water in the gill-chamber mentioned above, the morphology of the apparatus by means of which the crab is enabled to leave the water for long intervals of time was worked out. An opening is to be found between the third and fourth pereipods, which is fringed with hairs and leads up through a narrow channel to a space above the gills. It is provided with a valvular stop and with a structure which appears to function as a sense organ. It was ascertained that the crab does not "breathe air" as frequently stated, but aerates the water thus retained in its gill chambers.

(*d*) During the summer of 1912 a large number of fiddler crabs were captured and preserved for the purpose of determining the variation constants and the establishment of "place modes." It is planned to continue the work for a number of seasons in order to de-

termine if possible what effect climatic and environmental factors may have on the variability of the species. The now completed laborious task of measuring (involving over 10,000 measurements under a magnifying glass) has been carried out in the laboratory of the department of zoology of Washington University.

Dr. Abbott also made studies of the blood of *Thallasema*, an echiurid worm that inhabits the dead tests of the "sand dollar." This fluid is interesting from the standpoint of its corpuscles, which, like those of vertebrates, are of two kinds—ameboid forms and hemoglobin-bearing, respiratory cells. The individual cycle of these cells and their probable functions were worked out during the latter part of the summer, and the results are in press in the *Washington University Quarterly*. In about twenty-five per cent. of the worms studied the hemoglobin-bearing corpuscles formed were found to be parasitized by an undescribed species of *Hæmogregarina*—the first record of a hæmosporidian parasite in an invertebrate host. Portions of the life cycle of the form were worked out, and it is hoped to complete this at some future time.

Mr. L. F. Shackell, instructor in pharmacology, St. Louis, University School of Medicine, was engaged in a study of methods for protecting wood against the attacks of marine borers. Nearly seventy pieces of wood were coated with mixtures containing a variety of poisons, and are being allowed to remain in the water of Beaufort Harbor for nine months, the last three of which will coincide with the breeding season of *Teredo* and *Limnoria*.

Professor H. V. Wilson, of the University of North Carolina, spent a part of the summer in an investigation bearing upon the question of the reciprocal interaction of cells of different species, his observations dealing especially with the behavior of the amœbocytes in the lymph of the sea urchins *Arbacia* and *Toxopneustes*.

Dr. James J. Wolfe, professor of biology in Trinity College, Durham, N. C., spent seven weeks at the laboratory completing his investigation of *Padina*, begun here in the summer of 1910, so far as the work which had to be done at the seaside is concerned. Forty-eight cultures of eggs and tetraspores were started in aquaria in the laboratory and later transferred to various localities in the harbor. These were collected on a special trip made to Beaufort, September 25. A subsequent examination, not yet quite complete, shows fairly conclusively an alternation of a sexual with an asexual generation. From July 18 to September 1 general records were kept covering rate of growth, formation of hairs, and periodicity in the production of sex organs. The foregoing, together with a cytological examination at critical stages, is now being incorporated in a paper on "The Life History of *Padina*."

Dr. A. J. Goldfarb, of the College of the City of New York, visited the laboratory from August 6–17 in order to continue certain experiments begun earlier in the season at the Marine Biological Laboratory of the Carnegie Institution, on the grafting of eggs together and on certain changes produced by chemical means. Extensive dredging operations about the harbor and close to the laboratory appear to have polluted the harbor waters, and it was found necessary to bring in sea water from outside the harbor to secure normal development of the fertilized eggs of *Toxopneustes variegatus* into perfect plutei larvæ. With this water the eggs when subjected to the action of a $\frac{5}{8}$ *M* NaCl solution tended to fuse together in large numbers, and to continue their fusion into various types of single and double organisms. These fusions were produced in the same manner and gave rise to the same types of fusions as those obtained at the Tortugas earlier in the season, and established beyond all question that this new method for the production of fused eggs and larvæ is superior, in simplicity, in absence of disturbing physical factors, and in the number of fusions, to the methods formerly used by the writer, by Driesch and by Herbst.

Dr. Albert Kunz, of the University of Iowa, studied the habits, the morphology of the reproductive organs and the embryology of the viviparous fish, *Gambusia affinis*, and the early

developmental stages of two species of teleosts whose eggs were found in the plankton.

Gambusia affinis is exceedingly abundant in the vicinity of Beaufort in all the freshwater streams entering the harbor and in the shallow brackish waters. This species is of economic importance as a destroyer of insects and insect larvæ. Wherever it inhabits waters in which mosquitoes breed, the mosquito larvæ constitute its principal food. The introduction of these fishes into the natural waters as well as into artificial ponds, aquatic gardens, etc., in mosquito-infested regions, may play an important rôle in the extermination of these pests.

One of the most interesting points studied by Dr. Kunz was the structure of the apparatus controlling the modified anal fin in the male *Gambusia*. This fin functions as an intromittent organ and is controlled by a powerful muscle which has its origin on a bony process projecting ventrally from the fourth to the last abdominal vertebræ and the modified anal spines of the first three caudal vertebræ and is inserted on the proximal end of the anal fin rays. The third, fourth and fifth rays of the fin are enlarged, greatly elongated and variously curved, bearing short spines on their distal portions. The interhemal which articulates with the third ray is enlarged and sufficiently elongated to articulate with the two anterior processes, on which the muscle controlling the anal fin has its origin. The fifth ray may be drawn forward at one side of the fourth and brought into proximity with the third. In this manner a groove or tube is formed through which the milt is transferred from the male to the female. The results of this work are to be published in the near future.

On August 3, 1912, pelagic eggs of the two species of teleosts were taken in the tow-net. Both are spherical in form and comparatively small, having a diameter of .6 to .7 mm. One kind, probably those of *Trichiurus lepturus*, are almost perfectly transparent and contain no oil-globule. The other, perhaps those of an engraulid, contain an oil-globule and numerous minute pigment spots. Eggs taken at the same hour on successive days were found to be in approximately the same stage of development. Spawning obviously occurs in the evening, probably between five and eight o'clock. Before six o'clock in the morning the embryo is well differentiated, and at 36 hours after spawning the little fishes are already hatched. Observations on the development of these two species are still incomplete. It is expected that these studies will be extended and the species positively identified.

Following the work of Thompson, Johnson, Tims and Dahl on the scales of the salmon and English brook trout, with special reference to age determinations and life-history indications, Mr. H. F. Taylor, of Trinity College, Durham, N. C., undertook to verify and amplify their conclusions by investigating the scales of an important American food fish, *Cynoscion regalis* being chosen.

Age may be determined with more or less accuracy by enumerating the annuli or supposed zones of growth. Various methods of bringing out these annuli clearly by stains, polarized light, etc., were employed. The results will be explained in a paper to be published shortly.

The evidences found by Mr. Taylor do not warrant the assumption that annuli are due to retarded growth, as was hitherto supposed, but they must be due to other causes which are at present somewhat doubtful. At all events it is fairly certain that if these fishes grow more slowly in winter than in summer there is no evidence of this on the scales. Distances between the annuli are found to represent, proportionately, the length of the fish at the times of the formation of the several annuli.

The nature of the radii was also studied. They were found not to be constant, but to vary with the activity of the fish and with the part of the body from which the scale was taken. The evidence indicates that they are hinges through the superior calcified layer to permit the scale to bend in adaptation to the motion of the body of the fish. On the head, etc., where there is no flexibility, there are no radii on the scales; and their number on scales

from other parts agrees with the shape, size and thickness of the scale and the motion of the part. If this conclusion stands it will seriously modify systems of classification employing radii as characters.

Messrs. William J. Crozier and Selig Hecht, of the College of the City of New York, who were assigned to the director for duty, accompanied the various collection trips, made extensive collections of fishes and kept a complete record of all observations, devoting special attention to those relating to the food, habits, rate of growth, relative abundance and distribution of the fishes taken. They also studied correlations among weight, length and other body measurements of the squeteague (*Cynoscion regalis*). The coefficient of correlation of weight and length and the constant, which if multiplied by the cube of the length gives the weight of the fish, were determined. Stomach contents of a large number of examples of this species were examined. The results indicate that the relative proportions of the forms of life commonly eaten depend upon the size of the fish and that the food varies with the locality.

Lewis Radcliffe,
Director

SCIENTIFIC NOTES AND NEWS

Professor William Bateson, director of the John Innes Horticultural Institution, has been elected president of the British Association for the Advancement of Science for the meeting which will be held next year in Australia.

On the occasion of the meeting of the International Geological Congress at Toronto, the University of Toronto conferred the degree of doctor of laws on the following geologists: T. C. Chamberlin, U. S. A.; W. G. Miller, Canada; P. M. Termier, France; R. Beck, Germany; J. J. Sederholm, Finland; T. Tschermyschev, Russia, and A. Strahan, England.

Professor Lillien J. Martin, professor of psychology at Stanford University, has had the honorary degree of doctor of philosophy conferred upon her by the University of Bonn.

Professor Bier and Professor Körte, of Berlin, have been named as honorary members of the Royal College of Surgeons in London.

According to a note in *The Observatory* the American astronomers present at the meeting of the Solar Union at Bonn were: Campbell, St. John and Burns, from California; Stebbins, from Illinois; Parkhurst, Slocum and Gingrich, from Yerkes; Schlesinger, from Allegheny; Russell and Shapley, from Princeton; Ames, from Baltimore; Doolittle, from Philadelphia; Nichols, from Cornell; Pickering, Bailey, Miss Cannon and Mrs. Hastings, from Harvard; Miss Whiting and Miss Allen, from Wellesley, and Plaskett, from Ottawa.

Dr. Carl Correns, professor of botany at Munster, has been appointed director of the Research Institute for Biology of the Kaiser Wilhelm Society. Dr. Spemann, professor of zoology at Rostock, has been appointed assistant director.

Prince Galitzin has become director of the Observatoire Physique Central Nicolas, St. Petersburg.

Mr. Aksel S. Steen has been appointed director of the Meteorological Institute of Norway, in succession to Dr. H. Mohn, who has retired.

Mr. C. A. McLendon, for the past five years botanist and plant-pathologist to the Georgia Experiment Station, in charge of plant-breeding investigations, has tendered his resignation to take effect October the first, after which date he expects to be engaged in private business.

L. F. Hawley, Ph.D. (Cornell), formerly in charge of the section of wood distillation and chemistry of the U. S. Forest Service, is now the director of a forest products department recently established by Arthur D. Little, Incorporated, Boston, Mass.

Dr. Calvert M. DeForest has been appointed deputy health officer of the Port of New York. Dr. DeForest has recently returned from Libau, Russia, where he has been in the Public Health Service for the last five years.

FREDERICK G. CLAPP, of the Associated Geological Engineers, has returned from the gas fields of Hungary, and has gone to New Brunswick in company with Mr. Myron L. Fuller and Mr. Lloyd B. Smith of the same bureau.

MR. D. A. BANNERMAN has returned from a zoological mission to the eastern islands of the Canary group, undertaken with the object of procuring birds for the Natural History Museum, London.

SIR WILLIAM OSLER will distribute the prizes and deliver an address at St. George's Hospital on October 1.

THE lectures at the Harvey Society in the Academy of Medicine, New York City, will be inaugurated on October 4 by a demonstrative lecture by Dr. A. D. Waller, of London, entitled "A Short Account of the Origin and Scope of Electrocardiography." Subsequent lecturers are Professor Adolph Schmidt, Halle; Dr. Charles V. Chapin, Providence, R. I.; Dr. Rufus Cole, Rockefeller Institute; Professor G. H. Parker, Harvard; Dr. Victor C. Vaughan, Ann Arbor, Mich.; Professor Sven Hedin, Upsala, Sweden, and Professor J. J. R. Macleod, Western Reserve University.

A LECTURE will be delivered on October 7 at the University of Birmingham by Professor Arthur Keith, F.R.S., on "The Present Problems Relating to the Antiquity of Man."

A TABLET has been unveiled at Primiero, Southern Tyrol, on the house in which Alois Negrelli was born, to commemorate his work as surveyor of the Suez Canal.

MR. EDWARD LYMAN MORRIS, since 1907 curator of natural science in the Museum of the Brooklyn Institute and since 1898 special plant expert of the U. S. National Museum and the U. S. Department of Agriculture, died on September 14, aged forty-three years.

PROFESSOR MOSES CRAIG, formerly professor of botany at the Oregon Agricultural College and botanist of the station, later in charge of the herbarium of the Shaw Botanical Garden, St. Louis, died on August 31. He was graduated from the Ohio State University in 1889 and received a master's degree from Cornell University in 1890.

WE learn from the London *Times* that the future of the educational museums, founded and equipped by the late Sir Jonathan Hutchinson, at Haslemere, Selby (Yorks), and 22, Chenies-Street, London, is causing some concern. In his will Sir Jonathan leaves the museums to his trustees to dispose of as they may think best. In his lifetime he spent on the museums and their equipment at least £30,000. At Haslemere there is a strong feeling that everything should be done to retain the museum for the town, and it is understood that the family are willing to hand it over to a responsible committee or body of trustees so that the museum may be placed on a permanent and public basis. The annual cost of maintenance on present lines is about £400, and an appeal will shortly be issued with the hope of securing this sum for five years at least, it being thought that by that time those who are interested in the matter will have had an opportunity of deciding what are the best steps to be taken for the permanent control and maintenance of the museum.

UNIVERSITY AND EDUCATIONAL NEWS

BY the will of Miss Katherine Allen, of Worcester, the Worcester Polytechnic Institute received a bequest amounting to about $100,000.

MRS. RUSSELL SAGE has given $34,000 to Syracuse University, of which $30,000 is for the Joseph Slocum Agricultural College.

MRS. ELLA STRONG DENISON, widow of the late Dr. Charles Denison, proposes to give a medical building to the University of Colorado. The wings will be used for laboratories, and the central tower will have a lecture room and a library. The west wing is now being built. It will be called the Henry S. Denison Laboratory in memory of Mrs. Denison's son, who was a member of the University of Colorado faculty.

FROM the list of doctorates conferred by American universities, published in SCIENCE

for September, there were omitted four degrees given by the University of California: The recipients were: Harold Childs Bryant, in zoology; Wilson Gee, in zoology; Harry Noble Wright, in mathematics, and Friedrich Alexander Wyneken, in German.

DR. A. G. POHLMAN, of Indiana University, has accepted the professorship of anatomy in the school of medicine in St. Louis University.

DR. C. L. ANDREWS, of the Johns Hopkins University, has been appointed professor of anatomy in the University of Mississippi Medical College.

DR. LEONARD W. ELY, of Denver, Colorado, was appointed associate professor of orthopedic surgery, and Dr. Ralph W. Majors, instructor in pathology, at a recent meeting of the board of trustees of Stanford University. On October first there will be opened a clinic in orthopedic surgery in quarters which are being fitted up for the purpose in the medical school buildings in San Francisco.

RALPH W. CURTIS, B.S.A., who was for four years assistant superintendent of the Arnold Arboretum of Harvard University, has been appointed assistant professor of landscape art in the college of agriculture of Cornell University.

JOSIAH MAIN, of the State Normal School, Hays, Kansas, has been appointed professor of agriculture for schools in the State Agricultural and Mechanical College, at Stillwater, Oklahoma.

PAUL S. WELCH, Ph.D. (Illinois), has been appointed instructor in entomology in the Kansas State Agricultural College, and assistant entomologist of the experiment station to fill the place made vacant by the resignation of Dr. M. C. Tanquarry, who is accompanying the Crocker Land Arctic Expedition. Dr. John W. Scott, assistant professor of zoology and assistant station zoologist in charge of investigations in parasitology in the Kansas State Agricultural College, has resigned to become professor and head of the department of zoology and parasitology in the University of Wyoming. J. E. Ackert, Ph.D. (Illinois), has been appointed to the position in Kansas made vacant by Dr. Scott's resignation.

THE following appointments to the faculty of the Alabama Polytechnic Institute and Experiment Station have just been made: Professor Ernest Walker, graduate of Cornell, formerly the head of the department of horticulture in the University of Arkansas, to be head of the department of horticulture; G. S. Templeton, B.S. (Missouri, '11), who has been for the past two years instructor in animal industry in the Texas College, to be head of the department of animal industry; L. S. Blake, a graduate of the University of Michigan, becomes acting head of the department of pharmacy as substitute for Professor E. R. Miller, who becomes acting assistant professor of plant chemistry in the University of Wisconsin. Lucius W. Summers, who has been assistant professor of animal industry for the past two years, has resigned to accept the position of professor of animal industry in the Virginia Polytechnic Institute.

DR. J. AUSTIN BANCROFT has been appointed by the governors of McGill University Dawson professor of geology.

DR. A. D. IMMS has been appointed to the newly created post of reader in agricultural entomology at the University of Manchester. Dr. Imms was formerly professor of biology in the University of Allahabad, and afterwards forest entomologist to the government of India at the Imperial Research Institute, Dehra Dun.

DISCUSSION AND CORRESPONDENCE

THE DATA OF INTER-VARIETAL AND INTER-SPECIFIC COMPETITION IN THEIR RELATION TO THE PROBLEM OF NATURAL SELECTION

TO THE EDITOR OF SCIENCE: Biometricians have clearly demonstrated[1] that of the variations which occur within the limits of the species some have far less chance of survival than others. In short, the intra-specific death

[1] See several papers in *Biometrika* and two general reviews in the *Popular Science Monthly* for 1911 and 1913.

rate is selective. The difficulties, however, of the problem of natural selection, the least investigated of all of the primary factors of organic evolution, demand the collection of evidences from every possible source.

The purpose of this letter is to call attention to inter-varietal and inter-specific competition as a source of information on natural selection, to illustrate the point by one or two recently published observations, and to urge the accumulation of more (and more precise) data of this kind by those field naturalists and experimentalists who have the opportunity for this sort of work.

The kind of studies to which I refer are illustrated by Brimley's interesting account[2] of the capture of Raleigh, N. C., by the wharf rat, *Mus norvegicus*. Up to 1909, the roof rat, *M. alexandrinus*, was the only species seen during a residence of twenty-five years. Since then it has been nearly or entirely replaced by the wharf rat.[3]

For a second illustration turn to botanical material.

Varieties of plants are generally believed to differ in their susceptibility to disease. An interesting demonstration of this is furnished by researches on the potato fungus, *Phytophthora infestans*. Jones, Giddings and Lutman have shown[4] that there is a correlation between the percentage growth of the fungus on various varieties in the test-tube and the percentage of rot observed in field trials on clay and sandy soil by Stuart. They find for laboratory growth and loss on clay a correlation of $r = .584 \pm .059$ and for laboratory and sandy soil a correlation of $r = .594 \pm .055$.[5] For convenient comparison I have also worked out the correlation between the percentage rot of the same varieties on clay and sandy soil, using Stuart's data as quoted by Jones and his associates. For the ungrouped material $r = .707 \pm .045$.

Clearly enough there is a pronounced individuality in the varieties with respect to their capacity for resisting disease. The interest of such a result from the standpoint of natural selection is clear, for in free competition more susceptible strains would be rapidly weeded out, and the morphological or physiological characteristics to which their inferiority is due would be lost.

Now of course in neither of these cases do we know why (*i. e.*, because of what peculiar characteristics) one variety or species was less capable than another of survival. Nor can we know until the questions are more intensively studied. But one can not doubt that these problems will yield to proper and persistent observation.

My point is merely that this sort of work may (if carried out extensively and intensively enough) have a most important bearing upon the two fundamental questions of natural selection. First, is the death rate random or selective? Second, if selective, what weight has each individual character in determining the chances of survival of the individual? In seeking the answer to the second question it may be desirable to deal with characteristics as strongly contrasted as possible—with varietal or specific differences instead of with intra-varietal variations—in order that the proximate causes of the differential mortality may be more easily recognized.

The value of such work for the problem of natural selection will be quite supplementary to that for which it was primarily carried out. May we not, therefore, have more observations of this kind, carried out in such detail that they may be of value to the evolutionist seeking to ascertain the selective value of individual characters?

J. ARTHUR HARRIS
STATION FOR EXPERIMENTAL EVOLUTION,
August 20, 1913

[2] Brimley, C. S., "Capture of Raleigh by the Wharf Rat," *Journ. Elisha Mitchell Sci. Soc.*, 28: 91–94, 1912.

[3] Dr. Hatai tells me that when he placed white rats on an island inhabited by the brown rat, *M. norvegicus*, the two forms at once established different centers and began fighting each other. See also *Year Book Carn. Inst. Wash.*, 10: 83–84, 1912.

[4] Jones, L. R., N. J. Giddings and B. F. Lutman, *Bull. Vt. Agr. Exp. Sta.*, 168: 74–81, 1912.

[5] These are calculated on grouped data. I have recalculated without classing and find results agreeing within less than half the probable error.

PREPOTENCY IN AIREDALE TERRIERS

I HAVE recently had occasion to make a careful analysis of the ancestry and get of Airedale terriers. In view of the fact that this variety of dogs was manufactured only some fifty years ago out of known materials[1] and now breeds true to type the results are interesting, especially when compared with Davenport's studies in trotting-horse pedigrees.[2]

The records of the English and American Kennel Clubs' Stud Books show that to January, 1913, 80 dogs and 69 bitches have won their championship in both countries. Since to become a champion, a dog must receive a certain number of awards under at least three different judges, it is safe to assume that winners of the title are above the average of the variety. Certainly to breed a champion is the object of dog fanciers' breeding experiments.

Of the 80 dog champions, 39 were sired by champions. Of the 80 champions 38 had one grand-sire a champion, and 23 champions had both grand-sires champions. Just one less than half of all dog champions were sired by a champion, and about three fourths had either one or both grand-sires champions.

Of the 80 dog champions, however, 53 never sired a champion of either sex. Only 27 of the dog champions produced championship winners. Of these 27 sires of champions, but 13 produced more than one champion. However, these 13 exceptional sires produced 49 of the 149 Airedale champions; almost a third of all the champions of both sexes.

In the second generation, sons of champions sired 47 dog and 38 bitch champions, and daughters of champions were the dams of 43 dog and 22 bitch champions. It should be noted that champions both of whose grand-sires were champions get into these figures twice, as both the get of a champion's son and also of a champion's daughter. Of the 80 dog champions, 17 are bred this way.

Of the 80 dog champions, however, only 24 actually appear as grand-sires of champions, and but 10 are the grand-sire of 4 or more champions. Even more striking evidence of the prepotency of certain dogs as producers of champions is that those dogs who sired 2 or more champions almost invariably appear among those whose sons and daughters have produced more than 4 champions. The exceptional sires are also the exceptional grand-sires. The following table shows the champions in the ancestry and get of these exceptional breeding individuals.

Champion Ancestry					Champion Get					
No.	Sire	Dam	Grand Sires	Grand Dams	Sire of		Sire's Sire		Dam's Sire	
					♂	♀	♂	♀	♂	♀
5			1	1	2	2	1			1
9							2	1	2	
17	1		1		5	3	8	4	6	6
21			2		5	1	7	5	1	2
22	1		1			2	1		1	
28					1	2	1			
44			1		4	1	12	10	7	2
45			2		1	1	5	3		3
47	1		1		1		2	1	3	1
53	1	1	1		2	1				
56	1		1				2	1	1	
58					2	1	1	2	3	1
59	1		1		4					
65	1		2			2		3	1	
66	1				1	2				
72	1				2	2	3	5	2	2
16	9	1	8/3	1	30	20	15	35	27	18

These 16 champions have sired 50 champions, or, in other words, a third of all the Airedale champions have been sired by something less than a third of the dog champions.

Moreover, a glance at the pedigrees of these 16 phenomenal producers show them all to be more or less closely related. All trace back to Cholmondeley Briar (No. 9 in the above table). The three greatest producers of the lot are Master Briar (44), Clonmel Monarch (17), and Crompton Oorang (21). Master Briar is a grand-son of Cholmondeley Briar and the sire of Clonmel Monarch. Crompton Oorang is by a son of Master Briar out of a daughter of Clonmel Monarch. Without tracing out all the relationships in the dogs of the table, it may be said that the two living dogs (21 and

[1] Buckley, "The Airedale Terrier," 1907; Haynes, "The Airedale," 1911; Palmer, "All about Airedales," 1912.

[2] "Principles of Breeding," pp. 551–567.

Squire Crompton Oorang and his son, Rockley Oorang.

Practically all show dogs are placed at public stud, and any champion, thanks to the advertising his winnings give him, will be popular. The 53 champions who never sired a champion can not therefore be excused on the plea of lack of opportunity. They would certainly receive more bitches than a non-champion, unless this dog had made a great reputation as a sire.

The full table, showing the ancestry and get of all Airedale champions, and a similar one for Scottish terriers will be published in my forthcoming book on dog breeding.

WILLIAMS HAYNES

MITOSIS IN THE ADULT NERVE CELLS OF THE COLORADO BEETLE

In a recent study of the development of the nerve cells through larval, pupal and adult stages in the honey bee, we had ample opportunity to note the method of division and growth. After the very early larval stages there is formed a regular mitotic figure in each multiplying nerve cell. These division figures are not equally abundant in all our material, which may account for the assumption that there is a rhythm in the normal growth of nerve cells. Mitosis does not stop at the end of the larval period, but continues for a time in the pupal stage. We have observed perfect mitotic figures in bees in the early pupal stages of metamorphosis. These figures are exactly like those occurring in the larval stages.

The larval life of the honey bee is relatively inactive, which affords an interesting contrast with the active existence of the common potato beetle. The results of this comparison will appear in a separate paper. While making the comparative study of the larval as well as pupal and adult stages in the growth of the nerve cells we noted in some of the adult material unmistakable evidence of nerve cell division. Close examination showed that there were many nerve cells in one animal dividing in the normal mitotic manner. Centrosomes, spindle fibers and astral rays were all complete. The chromosomes were too compactly massed to be counted. In one field of the 2 mm. oil immersion objective we found six cells undergoing division. Others appeared in other parts of the ganglionic mass.

Our study upon the growth of the nerve cells in the honey bee and the potato beetle indicate that we may expect to find nerve cells regularly dividing by mitosis through the pupal and into adult life.

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SCIENTIFIC BOOKS

Sigma Xi Quarter Century Record and History 1886–1911. Compiled by HENRY BALDWIN WARD, Secretary of the Society of the Sigma Xi, with the assistance of the Chapter secretaries. University of Illinois. Urbana-Champaign. Pp. xii + 542.

A brief statement of the society whose achievements for a quarter of a century are given in the octavo volume which has just been published under the above title will perhaps best describe its importance.

In the early spring of 1886 the feeling that students of science who were not eligible to election in the well-known honor college fraternity, Phi Beta Kappa,[1] should organize a similar honor society to which those worthy followers of Agassiz, Darwin and Haeckel should be admitted was clearly recognized at more than one college, and especially at those universities where science was made an important feature of the curriculum.[2]

Accordingly, at Cornell University in November, 1886, the society of the Sigma Xi was

[1] Organized in 1776 at William and Mary College in Virginia.

[2] Let me call attention at this point to the fact that very early in the history of the School of Mines of Columbia University in New York those students who were able to enter the senior class without conditions were given the privilege of wearing the badge of crossed hammers in the course of mining engineering, and of the Liebig's potash bulbs in the chemical course.

organized. It takes its name from the initial letters of two Greek words signifying "Companions in Zealous Research." The object of the organization, as given in its constitution, is to encourage original investigation in science, pure and applied, by meeting for the discussion of scientific subjects; by the publication of such scientific matter as may be desirable; by establishing fraternal relations among investigators in the scientific centers; and by granting the privilege of membership to such students as during their college course have given special promise of future achievement.

Membership in this society is of three kinds: active, alumni and honorary. Naturally the first class is the most important and includes, as a rule, professors, instructors, graduates and such undergraduates as may be found worthy. The undergraduates are usually chosen in the senior year, following in this respect the custom of Phi Beta Kappa, although in some institutions, as, for instance, the University of Chicago, it has been the policy to admit only graduate students to membership. The alumni members are chosen from graduates of at least five years' standing, who have demonstrated their right of membership by investigation, while honorary members may be selected from those who have achieved eminence as scientific workers, although as yet none such have been elected.

From the beginning it was evident that the society would succeed. Chapters were organized at Rensselaer and Union in 1887, at Kansas in 1890, and at Yale in 1895. In addition to the foregoing there are now chapters at Minnesota (1896), Nebraska (1897), Ohio (1898), Pennsylvania (1899), Brown (1900), Iowa (1900), Stanford (1901), California (1902), Columbia (1902), Chicago (1903), Michigan (1903), Illinois (1903), Case (1904), Indiana (1904), Missouri (1905), Colorado (1905), Northwestern (1906), Syracuse (1906), Wisconsin (1907), Washington (1907), Worcester (1908), Purdue (1909) and Washington, St. Louis (1910).

The membership in 1886 was but 14, but it has grown steadily and persistently ever since; for in 1891 it was 267, in 1901, 1,559, and in 1911, 7,498, which number is annually increased by between 600 and 700 (659 in 1911) new members, of which in 1911 394 were undergraduates.

Annual conventions are held on the Tuesday evening of the week of the meeting of the American Association for the Advancement of Science, at which time the policy of the society comes up for discussion and such other public business as may be desired. Delegates from the chapters, together with the general officers, are members of the Council.

It is not easy to review the achievements of Sigma Xi during its existence of a little more than a quarter of a century. This difficulty lies in knowing just what to say. There is no danger of saying too much, but there is decided danger in saying too little. Its mission is to encourage science and to foster original investigation.

Science has been distinctly advanced by the popular public lectures and addresses made before many of the chapters by such eminent authorities as Charles F. Chandler, R. H. Chittenden, George W. Goethals, G. E. Hale, L. O. Howard, David Starr Jordan, A. A. Michelson, C. S. Minot, E. W. Morley, E. L. Nichols, C. R. Van Hise, Arthur G. Webster, Harvey W. Wiley and many others.

In the celebrations of the centenary of Darwin's birth, it took an active part, and important commemorative meetings with appropriate addresses were held when the bicentenary of Franklin's birth occurred.

Of far-reaching importance was the investigation by the California chapter of the condition actually existing in the region about San Francisco concerning the bubonic plague and the results of the report were most potent at a time when the existence of that frightful disease on the Pacific coast was disputed.

Not the least of its valuable contributions is the fact that it has brought about an increased interest in Phi Beta Kappa. It affiliates agreeably with its older rival at Columbia, Kansas, Minnesota and Pennsylvania, alternating addresses at commencement at certain of these universities, and holding joint meetings at others. The existence of Tau Beta Pi, the honor fraternity in institu-

tion of applied science, is, I am sure, very largely due to the success of Sigma Xi.

Sigma Xi stands "for intellectual energy rather than sordid ambition," and the volume so ably compiled by Professor Ward richly demonstrates the fact that it "has become a prominent factor in most of our universities." In the words of one of its founders in consequence of its influence:

> Men have come to know that knowledge of the present is far more important than tradition—that individual discernment, power of initiative, and honesty, surpass all authority in the equipment of a scholar of the new sort.

MARCUS BENJAMIN

An Introduction to the Chemistry of Plant Products. By PAUL HAAS and T. G. HILL. Published by Longmans, Green and Co., London, New York, Bombay and Calcutta. 1913. Pp. xii + 401.

The progress of chemistry, perhaps more than of any other science, may be divided into great epochs, in each of which one branch of the science is found to be far more productive of permanent results than are the other divisions.

The centuries-long period of alchemy gradually merged into the period when chemical researches were conducted with the view of enlarging the number of compounds which could be utilized in medicine.

Following the discovery of the nature of combustion, we begin to find the first organized chemical research, devoted in the main to inorganic chemistry, which rewarded us with a gradually increasing number of elements, with the atomic hypothesis, and the gas laws.

Thus until 1828 nearly all of the chemical investigations were confined to inorganic chemistry, for the compounds of carbon were supposed to be formed only by the action of life. When, however, Wöhler made his famous synthesis of urea, a new field was opened and the immense number of organic compounds listed in "Beilstein" are in a large measure the result of the studies of the period of organic chemistry.

For a time organic chemistry overshadowed inorganic chemistry until, under the leadership of men like Arrhenius, Ostwald, Nernst and Van't Hoff, a new chemistry was created which we know as physical chemistry. And even in our own time we have seen the science of radioactivity follow the discovery of radium by Mme. Curie.

During all of these advances the chemistry of the life processes has been more or less neglected. To be sure, a great many of our universities list courses in "physiological chemistry," but until very recently these have been devoted almost entirely to the study of nutrition and the chemistry of pathology, and even to-day the study of the chemistry of the life processes is only at a beginning. This is perhaps necessary, for it would be a useless task to undertake to determine and measure the life processes without the exact knowledge furnished by the organic and physical chemists.

We are thus, probably, near the beginning of a period of biological chemistry, not only the chemistry of animal life, but the chemistry of plant processes as well, not only from the standpoint of the physician and utilitarian, but from the broader standpoint of the study of life itself, its chemical products and the laws by which it is governed.

We have many admirable text-books dealing with physiological chemistry, but text-books which are suitable for a course in plant chemistry are rare. This may perhaps in part explain the absence of such courses from the curricula of our universities. It is, therefore, a pleasure to find such a book as "An Introduction to the Chemistry of Plant Products."

Modeled somewhat after Hoppe-Seiler's "Handbuch der physiologisch- und pathologisch-chemischen Analyse," but dealing only with plant products, there is a wealth of information in the 400 pages. Each group of plant constituents is discussed, first under the general group, then under the group subdivisions, and lastly each compound is given, its structural formula (when known), its properties, its chemical reactions, its micro-chemical reactions in many cases, the qualitative tests

for its presence, and the methods for its quantitative estimation. The quantitative estimation is illustrated in a majority of the cases by an example, so that the student can not go astray. Perhaps in some of these cases the calculations could have been omitted, for many are so simple that any one who could understand the directions should be able to calculate percentage, etc., but it is better to err in being too explicit rather than be too obtuse.

The literature has been well reviewed, but, unfortunately, the book contains no author index, so that the numerous author citations lose a very considerable part of their value. It is to be hoped that this feature will be remedied in a second edition.

The book is well printed on good paper, and is remarkably free from typographical errors. It should prove a useful volume to the average chemist, and invaluable to the plant physiologist or the teacher of plant chemistry, both as a reference book and as a text-book. Needless to add it should be in every chemical library.

ROSS AIKEN GORTNER

SPECIAL ARTICLES

THE ORGANIZATION OF THE CELL WITH RESPECT TO PERMEABILITY

IN studies on permeability it is assumed that we need consider but one surface, namely, the outer "plasma membrane." It seems desirable to emphasize that the problem really involves a variety of surfaces[1] the permeability of which may be decidedly different.

Good illustrations of this may be found in many kinds of plant cells. A very favorable object for investigation is afforded by the marine alga *Griffithsia*. Within the cell wall is a thin layer of protoplasm which surrounds a large central vacuole. The protoplasm therefore forms a sack which is filled with liquid. It is capable of expanding or contracting as water is taken up or withdrawn by osmotic exchange.

[1] The term surface is preferred, since a semi-permeable surface may exist where there is no definite membrane.

If these cells be placed in hypertonic sea water water is withdrawn from the cells and the protoplasmic sack contracts: on replacing the cells in sea water the sack expands to its original size. If in place of hypertonic sea water we use hypertonic NH_4Cl the sack likewise contracts, but the inner wall of the sack contracts a great deal more than its outer wall. The space between the two surfaces which is normally very small may increase until in places it equals one third of the length of the cell.

There are, therefore, two surfaces, the outer surface of the protoplasm ("plasma membrane") and the inner surface (vacuole wall) which do not act alike with respect to permeability. The interpretation of their behavior may be twofold. In the first place, the outer surface may be regarded as more permeable to NH_4Cl than the inner. The salt would therefore cause the outer surface to contract less than the inner since it is well known that the more freely a substance penetrates the less is its plasmolyzing power.

On the other hand, we may have to do with an alteration of permeability produced by the NH_4Cl. If the NH_4Cl produces an increase of permeability it may cause a contraction by what has been called false plasmolysis.[2] If the false plasmolysis of the inner surface is greater than that of the outer the effect which we have witnessed may result.

It is of course quite possible that both of these interpretations are correct and that we have both true and false plasmolysis contributing to the result. The writer is inclined to think that this is the case.

By lowering the concentration of the NH_4Cl we can produce a marked contraction of the inner surface while the outer still retains its full turgidity and shows no sign of contraction. This is most strikingly shown where a living cell adjoins a dead one. The turgidity of the living cell causes its end wall to bulge into the dead cell. As soon as the living cell loses its turgidity the end wall ceases to bulge and becomes nearly flat. It is therefore easy to determine whether the cell is turgid or not.

[2] Cf. *Bot. Gazette*, 46: 53, 1908; 55: 446, 1913.

Further experiments show clearly that false plasmolysis plays a part in this process, for hypotonic solutions or even tap water or distilled water may produce a contraction of the inner surface while the turgidity of the outer surface is maintained.

The chromatophores are numerous and lie embedded between the inner and outer surfaces of the protoplasmic sack. They contain chlorophyll and likewise a red pigment which is soluble in water. The red pigment is unable to escape from the chromatophore into the protoplasm under normal conditions because the surface of the chromatophore is impermeable to it. When the separation of the inner and outer surfaces of the protoplasm reaches a certain point the surface of the chromatophores usually becomes permeable to the red pigment, so that it diffuses out. The cells then present a very striking appearance. The contracted vacuole remains colorless while all the space between the inner and outer surfaces of the protoplasm becomes deep red. The red pigment can not escape through the outer surface, nor can it pass through the inner surface into the vacuole. The cell may remain in this condition for an hour or two. Finally the red color begins quite suddenly to diffuse through both the protoplasmic surfaces.

The nuclei behave as though their surfaces were impermeable to the red pigment at the start, but they appear to become permeable to it soon after it begins to diffuse out from the chromatophores.

The cell wall which encloses the protoplasm is freely permeable to the red pigment and to salts at all times, but is quite impermeable to many other substances.

Similar effects have been observed in a variety of other cells.

Whether these effects are due to true or to false plasmolysis or to a combination of both, it is evident that the various kinds of surfaces (i. e., the inner and outer protoplasmic surfaces, and those of the chromatophores, of the nuclei and the cell walls) can be proven to differ greatly in their behavior with respect to permeability.

The term differential permeability may be suggested as an appropriate designation of these phenomena.

The conception of differential permeability may perhaps be extended to surfaces other than those described here. Since the protoplasm is composed of a variety of structures (down to those which are ultramicroscopic) and each of these has a surface it is quite possible that many kinds of semi-permeable surfaces exist within the cell.

W. J. V. OSTERHOUT

HARVARD UNIVERSITY,
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THE SOCIETY OF AMERICAN BACTERIOLOGISTS. II

SANITARY BACTERIOLOGY

Observations upon the Bacteriology of the Baltimore City Water in Relation to the Typhoid Fever Present, and the Effect of the Hypochlorite Treatment: WILLIAM W. FORD and ERNEST M. WATSON.

Since October, 1910, up to the present time (December, 1912), a period of a little over two years, it has been possible for us to follow the bacteriological condition of the Baltimore city water by systematic examinations (weekly)—excepting for a brief period in the summer of 1911. These examinations have been of the nature of the bacterial count, the determination of the number of fermenting organisms present by means of the Smith tube, the isolation and determination of the various species present. The purpose of this work was (1) to determine the relation, if any, between the extent of the pollution and the amount of typhoid fever in the city, (2) to determine the seasonal variations in the bacterial content of the water and (3) to ascertain the effect of alum and hypochlorite of lime upon the city drinking water, as regards the bacterial content and later the effect of the purity or pollution of the water under these conditions upon the amount of typhoid fever in the city. It was found that in 1910 and 1911 there was a striking relation between the period of summer and fall pollution of the water and the summer rise in the amount of typhoid fever. The number of organisms in the water at this time ranged from 1,000 to 5,000 per cubic centimeter, and fermentation took place in 1/10 to 1/100 c.c.

and on one occasion in 1/1000 c.c. The entire significance of this relation will be fully determined only by further study. It further was found that the bacterial content of the city water during periods of pollution was different from that during periods of relative purity. *Bacillus coli* comprised 55 per cent. of all organisms isolated during the period of relative purity, while during the period of pollution it comprised only 25 per cent. of organisms present. At this latter time, however, several new forms made their appearance, such as *lactis aerogenes*, intermediate group, attenuated forms and "liquefying fermenters." During little more than a year now it has been possible to observe the effect of hypochlorite of lime and later of alum on the bacterial flora of the city water. In the main the bacterial count has been greatly reduced under the chemical treatment, the counts practically always being less than 500 organisms per cubic centimeter. Notwithstanding this, however, the degree of fermentation has remained practically the same, *i. e.*, 1/10 and 1/100 c.c. of the water giving positive tests in the Smith tube. The typhoid fever during this period of chemical treatment has been slightly reduced. However, the reduction was not at all striking, which makes us believe that perhaps the greater part of our typhoid fever may not be water-borne or, on the other hand, if water-borne, the specific organisms of pollution have not been removed from the water by the chemical treatment in the usual strengths of available chlorine.

Some Results of the Hypochlorite Disinfection of the Baltimore City Water Supply: J. Bosley Tomas and Edgar A. Sandman, Baltimore City Water Department.

Stokes and Hachtel[1] have reported the result obtained by the hypochlorite disinfection of the Baltimore city water supply during a period extending from the institution of the treatment on June 15, 1911, to October 30, 1911. They examined samples taken from the untreated water in the impounding reservoir and from the treated water after it had passed through each of two storage reservoirs. The result of their examination showed bacterial reduction varying between 94.5 and 99 per cent. They also showed average reduction in the colon bacillus from 57.5 per cent. positive tests with 0.1 c.c. of untreated water to 12 per cent. positive tests with 0.1 c.c. of treated water, and from 89 to 40 per cent. with 1 c.c. The greatest reductions were obtained with one part per million of available chlorin, when there were shown reductions from 86 per cent. positive tests with 0.1 c.c. of treated water, and from 100 per cent. to 37 per cent. with 1 c.c. The period covered by the following report extends from January to December, 1912. In addition to the places sampled by Stokes and Hachtel we obtained samples at the influent of the first storage reservoir, after the water had passed through seven miles of tunnel subsequent to treatment. The time required for the water to pass through this tunnel varies between 4.9 and 12.2 hours. While allowing sufficient time for effective disinfection, the taking of samples just before the water enters the first storage reservoir permits of counts being obtained before any after-growths are likely to have occurred. The amount of available chlorin applied during the period covered by the report of Stokes and Hachtel was raised from 0.4 parts per million applied at the start on June 15, to 0.6 on June 23 and to 1 on October 15. On July 15, 1912, the amount was again raised, by order of the Commissioner of Health, to 1.5 parts per million, and this amount has been maintained until the present time. From January 11 to November 12 aluminum sulfate, in amounts varying between 0.610 and 1.05 grains per gallon, was applied to the water as it entered the first storage reservoir. Shortly after the period covered by the report of Stokes and Hachtel after-growths in the storage reservoir caused excessive bacterial counts. These conditions maintained during the first five months of the year, but about the middle of May the counts showed a marked diminution, and no further after-growths were observed, excepting during the few days in September. The monthly averages of the results in bacterial counts and *B. coli* tests, shown in the accompanying table, are taken from daily analyses. The counts during the first six months were obtained on standard agar at 20°, and during the remainder of the year at 37°. The *B. coli* averages were obtained from tests made on portions of water varying by a multiple of ten from 0.001 c.c. to 100 c.c., sufficient number of tubes being used in each case to secure at least one negative and one positive test, excepting when no fermentation was obtained with 100 c.c. The average number of *B. coli* per cubic centimeter for each month was estimated by considering the number of positive and negative tests in each dilution and following the method described by Phelps before the American Public Health Association in 1907. Lactose bile was used as an

[1] *Am. Jour. Pub. Health,* April, 1912.

initial medium, and Endo's agar was used for isolating the members of the *B. coli* group in pure culture, nearly 100 per cent. successful isolations having been obtained by the use of this medium, whereas the frequent encountering of spreaders on litmus agar and the fact that many of the acid-forming colonies proved not to be members of the colon group seriously impaired the efficiency of this latter medium. No attempt was made until in the last two or three months to differentiate the four members of the colon group; but this is now being done with the use of dulcit, in addition to the usual sugars, and morphological examinations, and the results seem to show a greater vulnerability of the two *B. coli* organisms than of *B. aerogenes* and *B. acidi lactici*. The results obtained by the use of the 20° temperature show much greater reduction in the bacterial count than those obtained with the 37° temperature, and we believe that counts should be made at the higher temperature in addition to those made at 20°. The effects of the treatment of this water supply have been a very good reduction in the bacterial count of the water as it enters the first storage reservoir, and almost entire elimination of the members of the *B. coli* group, the treated water during three months showing none of these organisms at any time in 100 c.c. The reduction in the number of cases of typhoid fever occurring in Baltimore during 1912 is 31 per cent., compared with an average of the number of cases occurring during the years from 1906 to 1910, and 24 per cent., compared with the number of cases occurring during 1911, in the last six months of which the water supply was treated. We wish to acknowledge indebtedness to Mr. Ezra B. Whitman, water engineer, and to Mr. Emory Sudler, engineer in charge of the improvement of the water supply, for an interest unusual with the engineers not directly acquainted with the details of the laboratory work.

Experimental Disinfection of Water with Calcium Hypochlorite (preliminary note): F. W. HACHTEL, M.D., and RAYMOND FREAS, A.B., Bacteriological Laboratory of the State and City Boards of Health, Baltimore, Md.

The following brief report is made upon certain experiments that were begun in the midsummer of 1911 and which have for their object the determination of the amount of available chlorine necessary to eliminate the *B. coli* from 10 c.c. of water under varying conditions of turbidity. They were instituted because, although the quantity of available chlorine added to the Baltimore drinking water had gradually been increased from 0.4 to 0.75 parts to the million gallons, the colon bacillus still persisted with too great frequency in 1 and 10 c.c. of water collected at the storage reservoirs and as drawn from the taps. The first series of experiments had to be done in a hurry, as heavy rains on the watershed were markedly increasing the turbidity. At this time, therefore, only presumptive tests in lactose bile were done. This, however, is not a guide to the sanitary condition of water treated with hypochlorite of calcium as shown by some work carried on in the laboratory on samples collected from the taps and storage reservoirs after treatment. As a result of these we found that although they would not infrequently produce gas in lactose bile, we were unable to obtain the colon bacillus in pure culture even after repeated platings in lactose-litmus-agar. A number of these were then plated out anaerobically and in a considerable percentage of cases we obtained *B. welchii* or the *B. sporogenes* or both. This, therefore, led us to repeat our work, and the results may be summarized as follows: With a turbidity of 32 we have found that 0.75 and 1 part of available chlorine to the million gallons caused a bacterial reduction of about 80 and 90 per cent., respectively, in six hours. During the same period the bacterial content of the untreated water was doubled. At the end of twenty-four hours, although the untreated water showed a count of 300 times as great as when the experiment was started, the two treated waters gave counts of only 0.3 per cent., as great as that of the raw water at the beginning. Again, the water before treatment contained the colon bacillus in 1 c.c. but not in 0.1 c.c.; at the end of one hour after the addition of calcium hypochlorite in the aforementioned quantities 1 c.c. of the treated water failed to ferment. In addition, although there was gas formation in all the lactose-bile tubes inoculated with 10 c.c. for the first six hours after treatment, nevertheless the colon bacillus was not isolated from any of these, though they were plated out on three consecutive days. On the other hand, we were able to obtain *B. welchii* or *B. sporogenes* from almost all of them. Four, five, six and twenty-four hours after the addition of hypochlorite 50 c.c. of each of the treated waters were inoculated into large tubes of lactose-bile and although fermentation occurred in all save one, *B. coli* was not obtained from any of these in spite of repeated attempts. In every

instance but one *B. welchii* was present. It should be stated that the water was kept in the dark and at the out-of-door temperature. The calcium hypochlorite used had 34.1 per cent. of available chlorine. It is worth noting that in one experiment with water of a turbidity of 12 in which we used 0.75 part of chlorine per million the colon bacillus was present in 1 c.c. at the end of two hours and in 10 c.c. at the end of three hours. In addition to this, 10 c.c. of the treated water still caused fermentation at the end of six hours, but not after twenty-four hours. The colon bacillus, however, was not isolated from any of these. In this instance the bacterial content of the water was about one seventh as great as in the previously described case. This result is to be ascribed to the very low available chlorine content of the hypochlorite used—this being only 1.546 per cent. We have been unable to repeat the experiments with water of very high turbidity, owing to the lack of heavy rains on either of the two watersheds, but we purpose to do so at the first opportunity. Besides this we propose to determine if there is any relation between the temperature of the water treated and the amount of chlorine necessary to destroy *B. coli*. So far we can but state that, with water of a turbidity of about 30, a bacterial content of 15,000 and the colon bacillus present in 1 c.c. and not present in 0.1 c.c., 0.75 part of chlorine to the million gallons eliminates *B. coli* from 10 c.c. in one hour and from 50 c.c. certainly in four hours and possibly in less time; of course this presupposes the use of hypochlorite of high available chlorine content.

The Distribution of B. coli in Polluted Oysters: JOHN W. M. BUNKER, Ph.D., instructor in sanitary analysis, Harvard University.

To establish whether the distribution of *B. coli* in polluted oysters is or is not uniform throughout the regions of the oyster body, examination was made of the following regions of 145 oysters taken from regions subject to varying conditions of pollution in Narragansett Bay: shell liquor from the branchial chamber, material from the mouth, material from the stomach, material from the intestine at the point where it bends sharply upon itself, material from the extremity of the intestine, shell liquor from the cloacal chamber, decanted mixed shell liquor. As a result of these examinations it is evident that (1) the distribution of the colon bacillus is not uniform throughout the various regions of a polluted oyster; (2) of the body regions, the stomach, in general, contains the colon bacillus most frequently; (3) at all seasons of the year the colon bacillus is found more frequently in the shell liquor than in any portion of the body; (4) when the temperature of the water on the oyster beds is below [illegible] to 8° C., the best index of pollution as afforded by the *B. coli* test can be obtained from the liquor in the cloacal chamber; (5) at temperatures of above 8° C. the liquor in the branchial chamber is the most reliable source of information regarding pollution; (6) at no season of the year does the practise of decanting the shell liquor afford the most reliable index of pollution that could be obtained.

The Bacteriology of the Hen's Egg: LEO F. RETTGER, Sheffield Scientific School, Yale University.

In our investigations of bacillary white diarrhea in chicks we have made bacteriological examinations of at least ten thousand eggs. While our chief object was the detection of *B. pullorum*, the specific cause of the disease, a general bacteriological study was made of the eggs, and particularly those which were fresh and apparently normal. Until the spring of 1912 the yolks only were examined, as a rule. During the past year special tests were made with the whites. In the examination of the yolks of fresh and unincubated eggs the entire yolks were employed. They were removed aseptically and mixed in special test tubes of large diameter with 25 cubic centimeters of plain bouillon. The tubes were kept three to four days at 37° C., and for an additional period of twenty-four hours at 20°. Streaks were made with platinum loops on slant agar. Incubated eggs were tested directly, that is a small amount of the yolk was streaked over the surface of slant agar. In the testing of whites 5 cubic centimeters of the egg-white were mixed with 100 c.c. of sterile tap water. These tests were made in duplicate. One flask of the diluted white was kept for five to six days at 20° and the other at 37°. Slant agar streaks were then made. From the results of the numerous tests we were led to conclude that the yolks and whites of fresh eggs were, as a rule, sterile. Among the organisms found (aside from *B. pullorum*) the most conspicuous was a large spore-bearing bacillus, resembling in many ways *B. mesentericus*. In addition to this the following were observed: *Proteus vulgaris*, *B. pyocyaneus*, *B. fluorescens*, *B. coli*, cocci and moulds. It is quite probable that many of the organisms obtained in the tests were contamination forms. Eggs which were incubated artificially for from

one to three weeks seldom gave us any indications of containing bacteria. The only organism which could be regarded without doubt as coming from the interior of the egg was *B. pullorum*, and this was always found, when present, in the yolks of both fresh and incubated eggs. The results have been quite different, however, with eggs that were kept in warm, damp places for any length of time, and those which were left for several days under sitting hens. Such eggs, especially the infertile, frequently contained bacteria.

On Antiseptic and Bactericidal Properties of Egg White: JOEL A. SPERRY, 2d, M.S.

The white of the eggs was aseptically transferred to sterile test tubes in 5 cubic centimeter quantities and then inoculated with various organisms. Small amounts of the egg white were introduced into dilution flasks and agar plates were made with 0.5 c.c. of the dilution. The egg white showed strong bactericidal properties toward *Subtilis cereus* and *megatherium* while towards *coli, typhi, anthrax, Proteus vulgarus, Staphylococcus pyogenes aureus* and other organisms the antiseptic action only was noticeable. This was true for the white of fresh eggs and cold-storage eggs not more than nine months old. The action of egg white on *putrificus*, malignant edema and symptomatic anthrax seemed to be purely antiseptic. The white of eggs which are eleven months old or more showed a tendency to lose these properties.

SOIL BACTERIOLOGY

A New Method for the Bacteriological Examination of Soils: P. E. BROWN, Iowa State College, Ames, Iowa.

A brief statement of the situation regarding the bacteriological examination of the soils brings out as salient points that the mere quantitative examination of soils is of little value from the fertility standpoint; that the logical means by which conclusions can be reached concerning the influence of varying bacterial content on crop production consists of certain groups of organisms as measured by the chemical products of their growth and actual crop production; and that a necessity therefore for progress in the work is the formulation of satisfactory methods for measuring the activities of certain important groups of soil organisms. A discussion of the methods previously employed while recognizing certain value attached to the results obtained thereby, points out the objections to the solution method and to the use of sterilized or air-dry soil as media and the conclusion is reached that fresh soil is the logical medium to be employed. Plots differentiated through special treatment were employed in experiments and satisfactory results were secured using fresh soil with ammonium sulfate for nitrification and fresh soil with mannite for azofication. For ammonification more difficulty was experienced in selecting a suitable nitrogenous material to permit of an accumulation of ammonia in sufficient amounts to be measured. Comparisons of the results obtained using air-dry soil and infusions of fresh soil and dried blood, albumen and casein with those secured using fresh soil and the same nitrogenous materials showed that casein added in solution to fresh soil brought out the greatest differences in the ammonifying power of the soils and possessed also certain other advantages incident to manipulation. The method recommended consists then in testing of fresh soil obtained as described in previous work by the writer, adding a solution of casein for ammonification, ammonium sulfate for nitrification and mannite for nitrogen fixation.

A Cultural and Morphological Study of some Azotobacter: DAN H. JONES, Ontario Agricultural College, Canada.

From various samples of soil taken from the garden of the Ontario Agricultural College, sixteen colonies of *Azotobacter* were isolated. A study of these cultures extending over two years shows them to comprise four distinct varieties or species. These have been tentatively named *A1*, *A2*, *A3* and *A4*. *A1* and *A2* bear a resemblance to *Azotobacter chroococcum* and *A3* and *A4* bear a resemblance to *Azotobacter agilis*, as described by Beyerinck. All cultures in Ashby's solution fix atmospheric nitrogen in the form of nitrates. In young cultures (one to two days old) of each variety, the organism is a short, thick rod with rounded ends, frequently occurring in diplo form and motile by means of peritrichic flagella. At this stage, the internal protoplasm is homogeneous, though occasionally what may be a nucleus in the form of a spherical granule is present, this undergoing a fission when the cell divides. When cultures are four to five days old, the cells become irregularly spherical, coarsely granular and nonmotile. The granules enclosed are spherical, vary in size and number and are often of two kinds. The one kind of granule gives the glycogen reaction when treated with iodine-potassium-iodide solution, but is negative to certain anilin dyes, whereas the other kind is negative to the glycogen

stain but positive to the anilin dyes. This second kind of granules appear to arise from the aforementioned nuclear body, and the first mentioned kind appear to be a product of the cell activities, possibly a reserve food supply. In active cultures from five to ten days old, many of the cells disintegrate, their enclosed granules being scattered. The granules of the second type appear to give rise to new organisms, acting in this particular as gonidia, while those of the first type slowly disappear as though they were dissolved. At this stage, *A*1 and *A*2 produce large capsules, but *A*3 and *A*4 do not. Fission frequently takes place within these capsules, thus producing an irregular group of from two to six or more organisms within a capsule. When cultures are about three weeks old, the majority of the organisms appear as spheres, *A*1 and *A*2 in irregular clusters, *A*3 and *A*4 in fairly regular packet and sarcinæ forms. This condition occurs only when the cultures are near their full development and appears to be a resting stage. Chains of from four to thirty cells are common in old liquid cultures as Ashby's solution. Involution forms of a great variety in size and shape appear in old cultures, but the most striking changes in morphology occur in cultures incubated at 37° C., especially in case of *A*1, in which many of the cells elongate into tubes 40 or 50 μ long. Colonies and streak cultures on Ashby's agar are first hyaline, then white and when they are fully developed a brown pigment is produced, which in case of *A*2, *A*3 and *A*4 in time frequently becomes black. Mass cultures of *A*1 are very moist and have a tendency to flow; those of *A*2, while being moist, do not flow, but become contoured in topography; those of *A*3 are pasty; those of *A*4 somewhat coriaceous and verrucose. Ashby's media give the best growth, beef extract media allowing but a restricted development. Good growth on Loeffler's blood serum.

The Origin of Certain Organic Soil Constituents: M. X. Sullivan.

Examination was made of the dried mold, *Penicillium glaucum*, grown on Raulin's solution and of the filtered solution after mold growth for organic constituents. In the alcoholic soda extract of the mold were found oleic and palmitic acids and a fatty acid melting at 54° C., hypoxanthine, guanine, and adenine, histidine, thymine, choline, probably lysine and a small amount of hydroxy-fatty acids. In the direct alcohol extract was found mannite, cholesterol bodies, hypoxanthine and cerebroside. In the culture solution were found fatty acids, guanine, adenine and hypoxanthine, a small quantity of histidine, pentose sugar, unidentified aldehydes and a small amount of hydroxy-fatty acids. Most of these compounds have been found in soil and the conclusion is made that in the formation of the various organic soil constitutents, microorganisms, such as yeasts, bacteria and molds, play an important part.

Soil Inoculation under Soil Conditions of Lime Deficiency: T. D. Beckwith.

The Cascades divide the state of Oregon roughly into two sections differing greatly as to rainfall and consequent seepage of soluble soil constituents. Much of the land in the Willamette Valley and western section of the state has a lime deficiency of from one to five tons per acre-foot. With the idea of learning whether or not artificial inoculation of legume seed with pure cultures of *B. radicicola* might be expected to yield results, reports of success or failure of soil inoculation cultures furnished by the department of bacteriology have been sent to Oregon Agricultural College, accompanied by root specimens. During the past summer 110 tests have been carried out, at least 60 of which have been with alfalfa. A compilation of the results obtained shows that the method was beneficial in 69 per cent. of the experiments. On the contrary, of 50 tests carried out in the eastern part of the state in soils well furnished with lime, success was obtained in 45 instances, or 90 per cent. It is thus evident that *B. radicicola* may retain virulence to the roots of legume plants, under conditions of a small amount of soil acidity. Results were unfavorable when lime deficiency was over five tons per acre-foot.

Bacterial Activity in Soil as a Function on the Various Physical Soil Properties: Otto Rahn, University of Illinois.

To study the influences of physical soil properties upon bacterial activity in soil, pure cultures of *B. mycoides* in quartz-sand peptone water mixtures were studied. In one series, cellulose was added to the sand. The amount of ammonia formed under these conditions was taken as the indicator of bacterial activity. Further, *Bact. lactis acidi* was grown in milk sand mixtures, acidity and number of cells serving as measure of development. The conclusions are greatly influenced by the basis of comparison. If the data are computed per 100 g. of dry soil, as is customary among soil bacteriologists, it would seem that the bacteria thrive best in a fairly moist sand (20–25 per cent.). If, however, the actual culture

medium, *i. e.*, the peptone solution, is used as basis, ammonification is most rapid in the driest soil (10 per cent. water). If the data are computed per 100 c.c. of soil solution, the concentration of the solution is again of greatest importance. The results vary greatly if one time the peptone is given in proportion to the amount of soil and another time in proportion to the amount of soil moisture. The farmer is primarily interested in the amount of plant food per weight of soil; the efficiency of bacteria can be determined only by comparing equal amounts of culture medium and of food. In test tube or flask cultures of *B. mycoides*, oxygen is always in the minimum. In sand cultures, the oxygen exchange is greatly increased and the rate of development is correspondingly higher. The oxygen exchange between gas and liquid depends upon the oxygen content of the soil air and upon the surface exposed to this air. The surface per unit of liquid is inversely proportional to the diameter of the soil particles and to the moisture content of the soil. The oxygen content of the soil air depends upon the ventilation which is nearly proportional to the square of the grain diameter. A thinner film of moisture gives therefore a faster decomposition, but there is a limit to the thinness of this film, extremely thin films causing a retarded decomposition. The optimum thickness of moisture film in the case of *B. mycoides* was between 20 and 40 microns. This film was obtained in sand of 1 mm. diameter at a moisture content of about 10 per cent. In arable soils, with a grain size not more than 0.1 mm., it would require more than 50 per cent. of moisture to produce the optimum film thickness. In other words, strictly aerobic bacteria will never find optimum conditions of existence in soils. The ultimate endpoint of decomposition, if the food concentration was constant, was the same in the case of *B. mycoides*, since only the rate of decomposition was influenced by the efficiency of the oxygen supply. With some other bacteria, the endpoint varied greatly. The behavior of anaerobic bacteria, represented by *Bact. lactis acidi*, was in accordance with the abovementioned principles, the main factor for their development being a very thick moisture film. The physical effects of undecomposed organic matter were imitated by the addition of finely ground filter paper to sand. In fairly dry soils, cellulose caused a decrease of ammonia formation by making some of the soil moisture unavailable for bacteria. In the moisture sands, cellulose increased the ammonification probably by holding the sand particles farther apart and thus increasing aeration.

Characteristics of Cellulose-destroying Bacteria: I. G. McBeth, F. M. Scales and N. R. Smith.

Seventeen species of cellulose-destroying bacteria have been isolated and studied; 7 of these belong to the genus *Bacillus*, 4 to the genus *Bacterium* and 6 to the genus *Pseudomonas*. All are morphologically and physiologically different from Omelianski's hydrogen and methane ferments. None of the species studied have shown any tendency to form gaseous products, and in relation to oxygen all are facultative aerobes. By means of cellulose agar colonies the species may be separated into two distinct groups: those forming opaque colonies which clear a well-defined zone beyond the colony and those which form transparent colonies with little or no indication of an enzymic zone. All of the organisms grow more or less rapidly on beef gelatin, but only 10 of the 17 species studied have shown any power to liquefy gelatin. On beef agar 11 species grow rapidly and luxuriantly, 4 species grow poorly and 2 have failed to give any growth at all. When introduced into Dunham's solution 9 species have shown the power to form ammonia. The action on litmus milk is also quite variable; 10 species give an acid reaction, 5 an alkaline reaction and 2 make no growth. The digestion of the milk occurred with only 4 species. Eleven species have shown a growth on potato cylinders while 6 have shown no growth or only a slight bleaching action along the track of the inoculum. The action of the cellulose-destroying bacteria studied shows marked differences in their activity toward the other carbohydrates such as dextrose, lactose, maltose, saccharose, glycerine, mannite and starch in peptone solutions. In their relation to these solutions the cellulose-destroying organisms may be divided into the following groups: (1) those which give an acid reaction from all of seven peptone carbohydrate solutions used; (2) those which give an alkaline reaction from all of the peptone carbohydrate solutions; (3) those which give an acid reaction from only a part of the peptone carbohydrate solutions; (4) those which produce no change in the reaction of any of the peptone carbohydrate solutions.

A Plan for Revivifying Bacteria by Groups: H. J. Conn.

Our present standard method of revivification in non-saccharine broth at 37°, is not applicable

to most soil organisms nor to many other bacteria. A possible standard method is here suggested for revivifying the bacteria that do not grow under such conditions. The bacteria are to be divided into five groups:

1. Growing well in plain broth at 37° C.
2. Excluded from group 1, but growing well in plain broth at 20° C.
3. Excluded from groups 1 and 2, but growing well in dextrose broth at 37° C.
4. Excluded from groups 1, 2 and 3, but growing well in dextrose broth at 20° C.
5. Excluded from all four groups, but growing well on surface of agar.

Each of these groups is to have its own method of revivification, as follows: 1, in plain broth at 37° (as at present); 2, in plain broth at 20°; 3, in dextrose broth at 37°; 4, in dextrose broth at 20°; 5, on agar slants. This classification includes most soil bacteria and many others; but further groups may be added as they prove necessary. These groups are somewhat similar to the groups of the bases recognized by chemists in qualitative analysis. Like the chemical groups, they are to be disregarded after the unknown has been determined.

The Ammonifying Efficiency and Algal Content of Certain Colorado Soils: Walter G. Sackett.

The power to transform organic nitrogen into ammonia is a property common to many cultivated Colorado soils. Soils in the incipient stage of the niter trouble appear to surpass our normal soils in ammonifying efficiency. Compared with soils from other localities, our niter soils excel in ammonifying efficiency to a very marked degree. Nineteen of the thirty-one soils examined have ammonified cottonseed meal more readily than the other nitrogenous materials employed; the remaining twelve have broken down in the dried blood most easily; twenty-six have formed ammonia from alfalfa meal more readily than from flaxseed meal, and with five the reverse has been true. The maximum per cent. of ammonia produced in seven days by any soil from 100 mg. of nitrogen as cottonseed meal was 51.98 per cent.; as dried blood 52.64 per cent.; as alfalfa meal 34.85 per cent.; as flaxseed meal 12.15 per cent. Algæ occur abundantly in many cultivated soils of Colorado. Twenty-one different species of algæ were found in the soils examined. With but two exceptions, all the species found belong to the blue-green algæ (Cyanophyceæ.) The family Nostocaceæ is best represented. There is a predominance of forms possessing thick, gelatinous sheaths. This paper is published in full as Bulletin 184 of the Colorado Experiment Station, Fort Collins, Colorado.

Nitrogen Fixation by Organisms from Utah Soils: E. G. Peterson and E. Mohr.

This paper is a preliminary note in a proposed extensive investigation regarding the fixation of nitrogen in Utah soils and the rôle played by microorganisms in this action, together with the various agencies influencing bacterial action. Samples of soil from which the organisms described were isolated were taken weekly from January 9 to November 4, 1912, from Greenville Experiment Farm, Utah Experiment Station. 100 c.c. portions of mannite solution were inoculated with 10 grams of soil and incubated at 20° C. After ten days' incubation subcultures were made in mannite solution and incubated for ten days at 20° C. Isolations were made from plates which were made from these subcultures. Several types of colonies were formed, but only three appeared that grew readily and for a long period on mannite agar. The paper describes these three forms. One of the three forms was undoubtedly *Azotobacter chroococcum*, the other two heretofore undescribed in western soils. Type No. 1 fixed 5.335 mg. of nitrogen in twenty days in mannite solution, average of 15 tests; type 2 (*Azotobacter chroococcum*) fixed 5.616 mg. of nitrogen in twenty days, average of 10 tests; type No. 3 fixed 5.588 mg. of nitrogen in twenty days, average of 12 tests. Analyses were made from January 9 to October 28 to determine if possible any marked seasonal variations in nitrogen fixation. The technique involved the addition of definite quantities of soil, taken under standard conditions, to mannite solution, the amount of nitrogen in the soil being subtracted from the amount of nitrogen present at the end of twenty days in order to determine the amount fixed. The variation was found to be very marked from week to week without apparent regularity, a marked increase in fixation power being noted from the middle of May to the end of June. Isolations were made from these impure cultures to determine the presence of the three colony types described in the paper. Types No. 1 and 3 were present in the majority of samples, type No. 1 predominating in all cases. Type No. 2 was present once in April, twice in June and once in September. Further work is being done on the three forms isolated.

A. Parker Hitchens,
Secretary

(*To be concluded*)

SCIENCE

FRIDAY, SEPTEMBER 26, 1913

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

CONTINUITY.[1] *II*

THE so-called non-Newtonian mechanics, with mass and shape a function of velocity, is an immediate consequence of the electrical theory of matter. The dependence of inertia and shape on speed is a genuine discovery and, I believe, a physical fact. The principle of relativity would reduce it to a conventional fiction. It would seek to replace this real change in matter by imaginary changes in time. But surely we must admit that space and time are essentially unchangeable: they are not at the disposal even of mathematicians; though it is true that Pope Gregory, or a daylight-saving bill, can play with our units, can turn the third of October in any one year into the fourteenth, or can make the sun south sometimes at eleven o'clock, sometimes at twelve.[2]

But the changes of dimension and mass due to velocity are not conventions, but realities; so I urge, on the basis of the electrical theory of matter. The Fitzgerald-Lorentz hypothesis I have an affection for. I was present at its birth. Indeed I assisted at its birth; for it was in my study at 21 Waverley Road, Liverpool, with Fitzgerald in an arm chair, and while I was enlarging on the difficulty of reconciling

[1] Address of the president of the British Association for the Advancement of Science, Birmingham, 1913.

[2] In the historical case of governmental interference with the calendar, no wonder the populace rebelled. Surely some one might have explained to the authorities that dropping leap year for the greater part of a century would do all that was wanted, and that the horrible inconvenience of upsetting all engagements and shortening a single year by eleven days could be avoided.

the then new Michelson experiment with the theory of astronomical aberration and with other known facts, that he made his brilliant surmise: "Perhaps the stone slab was affected by the motion." I rejoined that it was a 45° shear that was needed. To which he replied, "Well, that's all right—a simple distortion." And very soon he said, "And I believe it occurs, and that the Michelson experiment demonstrates it." A shortening long-ways, or a lengthening cross-ways would do what was wanted.

And is such a hypothesis gratuitous? Not at all: in the light of the electrical theory of matter such an effect ought to occur. The amount required by the experiment, and given by the theory, is equivalent to a shrinkage of the earth's diameter by rather less than three inches, in the line of its orbital motion through the ether of space. An oblate spheroid with the proper excentricity has all the simple geometrical properties of a stationary sphere; the excentricity depends in a definite way on speed, and becomes considerable as the velocity of light is approached.

All this Professors Lorentz and Larmor very soon after, and quite independently, perceived; though this is only one of the minor achievements in the electrical theory of matter which we owe to our distinguished visitor, Professor H. A. Lorentz.

The key of the position, to my mind, is the nature of cohesion. I regard cohesion as residual chemical affinity, a balance of electrical attraction over repulsion between groups of alternately charged molecules. Lateral electrical attraction is diminished by motion; so is lateral electric repulsion. In cohesion both are active, and they nearly balance. At anything but molecular distance they quite balance, but at molecular distance attraction predominates. It is the diminution of the predominant partner that will be felt. Hence while longitudinal cohesion, or cohesion in the direction of motion, remains unchanged, lateral cohesion is less; so there will be distortion, and a unit cube xyz moving along x with velocity u becomes a parallelopiped with sides $1/k^2$, k, k; where $1/k^2 = 1 - u^2/v^2$.[8]

The electrical theory of matter is a positive achievement, and has positive results. By its aid we make experiments which throw light upon the relation between matter and the ether of space. The principle of relativity, which seeks to replace it, is a principle of negation, a negative proposition, a statement that observation of certain facts can never be made, a denial of any relation between matter and ether, a virtual denial that the ether exists. Whereas if we admit the real changes that go on by reason of rapid motion, a whole field is open for discovery; it is even possible to investigate the changes in shape of an electron—appallingly minute though it is—as it approaches the speed of light; and properties belonging to the ether of space, evasive though it be, can not lag far behind.

Speaking as a physicist I must claim the ether as peculiarly our own domain. The study of molecules we share with the chemist, and matter in its various forms is investigated by all men of science, but a study of the ether of space belongs to physics only. I am not alone in feeling the fascination of this portentous entity. Its curiously elusive and intangible character, combined with its universal and unifying

[8] Different modes of estimating the change give slightly different results; some involve a compression as well as a distortion—in fact the strain associated with the name of Thomas Young; the details are rather complicated and this is not the place to discuss them. A pure shear, of magnitude specified in the text, is simplest, it is in accord with all the experimental facts—including some careful measurements by Bucherer—and I rather expect it to survive.

permeance, its apparently infinite extent, its definite and perfect properties, make the ether the most interesting as it is by far the largest and most fundamental ingredient in the material cosmos.

As Sir J. J. Thomson said at Winnipeg:

> The ether is not a fantastic creation of the speculative philosopher; it is as essential to us as the air we breathe. . . . The study of this all-pervading substance is perhaps the most fascinating and important duty of the physicist.

Matter it is not, but material it is; it belongs to the material universe and is to be investigated by ordinary methods. But to say this is by no means to deny that it may have mental and spiritual functions to subserve in some other order of existence, as matter has in this.

The ether of space is at least the great engine of continuity. It may be much more, for without it there could hardly be a material universe at all. Certainly, however, it is essential to continuity; it is the one all-permeating substance that binds the whole of the particles of matter together. It is the uniting and binding medium without which, if matter could exist at all, it could exist only as chaotic and isolated fragments: and it is the universal medium of communication between worlds and particles. And yet it is possible for people to deny its existence, because it is unrelated to any of our senses, except sight—and to that only in an indirect and not easily recognized fashion.

To illustrate the thorough way in which we may be unable to detect what is around us unless it has some link or bond which enables it to make appeal, let me make another quotation from Sir J. J. Thomson's address at Winnipeg in 1909. He is leading up to the fact that even single atoms, provided they are fully electrified with the proper atomic charge, can be detected by certain delicate instruments—their field of force bringing them within our ken—whereas a whole crowd of unelectrified ones would escape observation.

> The smallest quantity of unelectrified matter ever detected is probably that of neon, one of the inert gases of the atmosphere. Professor Strutt has shown that the amount of neon in 1/20 of a cubic centimeter of the air at ordinary pressures can be detected by the spectroscope; Sir William Ramsay estimates that the neon in the air only amounts to one part of neon in 100,000 parts of air, so that the neon in 1/20 of a cubic centimeter of air would only occupy at atmospheric pressure a volume of half a millionth of a cubic centimeter. When stated in this form the quantity seems exceedingly small, but in this small volume there are about ten million million molecules. Now the population of the earth is estimated at about fifteen hundred millions, so that the smallest number of molecules of neon we can identify is about 7,000 times the population of the earth. In other words, if we had no better test for the existence of a man than we have for that of an unelectrified molecule we should come to the conclusion that the earth is uninhabited.

The parable is a striking one, for on these lines it might legitimately be contended that we have no right to say positively that even space is uninhabited. All we can safely say is that we have no means of detecting the existence of non-planetary immaterial dwellers, and that unless they have some link or bond with the material they must always be physically beyond our ken. We may, therefore, for practical purposes legitimately treat them as non-existent until such link is discovered, but we should not dogmatize about them. True agnosticism is legitimate, but not the dogmatic and positive and gnostic variety.

For I hold that science is incompetent to make comprehensive denials, even about the ether, and that it goes wrong when it makes the attempt. Science should not deal in negations: it is strong in affirmations, but nothing based on abstraction ought to presume to deny outside its own region. It often happens that things ab-

stracted from and ignored by one branch of science may be taken into consideration by another: Thus, chemists ignore the ether; mathematicians may ignore experimental difficulties; physicists ignore and exclude live things; biologists exclude mind and design; psychologists may ignore human origin and human destiny; folk-lore students and comparative mythologists need not trouble about what modicum of truth there may be in the legends which they are collecting and systematizing, and microscopists may ignore the stars. Yet none of these ignored things should be denied.

Denial is no more infallible than assertion. There are cheap and easy kinds of scepticism, just as there are cheap and easy kinds of dogmatism; in fact, scepticism can become viciously dogmatic, and science has to be as much on its guard against personal predilection in the negative as in the positive direction. An attitude of universal denial may be very superficial.

To doubt everything or to believe everything are two equally convenient solutions; both dispense with the necessity of reflection.

All intellectual processes are based on abstraction. For instance, history must ignore a great multitude of facts in order to treat any intelligently: it selects. So does art; and that is why a drawing is clearer than reality. Science makes a diagram of reality, displaying the works, like a skeleton clock. Anatomists dissect out the nervous system, the blood vessels and the muscles, and depict them separately—there must be discrimination for intellectual grasp—but in life they are all merged and cooperating together; they do not really work separately, though they may be studied separately. A scalpel discriminates: a dagger or a bullet crashes through everything. That is life—or rather death. The laws of nature are a diagrammatic framework, analyzed or abstracted out of the full comprehensiveness of reality.

Hence it is that science has no authority in denials. To deny effectively needs much more comprehensive knowledge than to assert. And abstraction is essentially not comprehensive: one can not have it both ways. Science employs the methods of abstraction and thereby makes its discoveries.

The reason why some physiologists insist so strenuously on the validity and self-sufficiency of the laws of physics and chemistry, and resist the temptation to appeal to unknown causes—even though the guiding influence and spontaneity of living things are occasionally conspicuous as well as inexplicable—is that they are keen to do their proper work; and their proper work is to pursue the laws of ordinary physical energy into the intricacies of "colloidal electrolytic structures of great chemical complexity" and to study its behavior there.

What we have clearly to grasp, on their testimony, is that for all the terrestrial manifestations of life the ordinary physical and chemical processes have to serve. There are not new laws for living matter, and old laws for non-living, the laws are the same; or if ever they differ, the burden of proof rests on him who sustains the difference. The conservation of energy, the laws of chemical combination, the laws of electric currents, of radiation, etc.—all the laws of chemistry and physics—may be applied without hesitation in the organic domain. Whether they are sufficient is open to question, but as far as they go they are necessary; and it is the business of the physiologist to seek out and demonstrate the action of those laws in every vital action.

This is clearly recognized by the leaders, and in the definition of physiology by

Burdon Sanderson he definitely limited it to the study of "ascertainable characters of a chemical and physical type." In his address to the Subsection of Anatomy and Physiology at York in 1881 he spoke as follows:

It would give you a true idea of the nature of the great advance which took place about the middle of this century if I were to define it as the epoch of the death of "vitalism." Before that time, even the greatest biologists—*e. g.*, J. Müller—recognized that the knowledge biologists possessed both of vital and physical phenomena was insufficient to refer both to a common measure. The method, therefore, was to study the processes of life in relation to each other only. Since that time it has become fundamental in our science not to regard any vital process as understood at all unless it can be brought into relation with physical standards, and the methods of physiology have been based exclusively on this principle. The most efficient cause [conducing to the change] was the progress which had been made in physics and chemistry, and particularly those investigations which led to the establishment of the doctrine of the conservation of energy. . . .

Investigators who are now working with such earnestness in all parts of the world for the advance of physiology have before them a definite and well-understood purpose, that purpose being to acquire an exact knowledge of the chemical and physical processes of animal life and of the self-acting machinery by which they are regulated for the general good of the organism. The more singly and straightforwardly we direct our efforts to these ends, the sooner we shall attain to the still higher purpose—the effectual application of our knowledge for the increase of human happiness.

Professor Gotch, whose recent loss we have to deplore, puts it more strongly. He says:

It is essentially unscientific to say that any physiological phenomenon is caused by vital force.

I observe that by some critics I have been called a vitalist, and in a sense I am; but I am not a vitalist if vitalism means an appeal to an undefined "vital force" (an objectionable term I have never thought of using) as against the laws of chemistry and physics. Those laws must be supplemented, but need by no means be superseded. The business of science is to trace out their mode of action everywhere, as far and as fully as possible; and it is a true instinct which resents the medieval practise of freely introducing spiritual and unknown causes into working science. In science an appeal to occult qualities must be illegitimate, and be a barrier to experiment and research generally; as, when anything is called an act of God—and when no more is said. The occurrence is left unexplained. As an ultimate statement such a phrase may be not only true, but universal in its application. But there are always proximate explanations which may be looked for and discovered with patience. So, lightning, earthquakes and other portents are reduced to natural causes. No ultimate explanation is ever attained by science: proximate explanations only. They are what it exists for; and it is the business of scientific men to seek them.

To attribute the rise of sap to vital force would be absurd, it would be giving up the problem and stating nothing at all. The way in which osmosis acts to produce the remarkable and surprising effect is discoverable and has been discovered.

So it is always in science, and its progress began when unknown causes were eliminated and treated as non-existent. Those causes, so far as they exist, must establish their footing by direct investigation and research; carried on in the first instance apart from the long-recognized branches of science, until the time when they too have become sufficiently definite to be entitled to be called scientific. Outlandish territories may in time be incorporated as states, but they must make their claim good and become civilized first.

It is well for people to understand this definite limitation of scope quite clearly, else they wrest the splendid work of biologists to their own confusion—helped, it is true, by a few of the more robust or less responsible theorizers, among those who should be better informed and more carefully critical in their philosophizing utterances.

But, as is well known, there are more than a few biologists who, when taking a broad survey of their subject, clearly perceive and teach that before all the actions of live things are fully explained, some hitherto excluded causes must be postulated. Ever since the time of J. R. Mayer it has been becoming more and more certain that, as regards performance of work, a living thing obeys the laws of physics, like everything else; but undoubtedly it initiates processes and produces results that without it could not have occurred—from a bird's nest to a honeycomb, from a deal box to a warship. The behavior of a ship firing shot and shell is explicable in terms of energy, but the discrimination which it exercises between friend and foe is not so explicable. There is plenty of physics and chemistry and mechanics about every vital action, but for a complete understanding of it something beyond physics and chemistry is needed.

And life introduces an incalculable element. The vagaries of a fire or a cyclone could all be predicted by Laplace's calculator, given the initial positions, velocities and the law of acceleration of the molecules; but no mathematician could calculate the orbit of a common house-fly. A physicist into whose galvanometer a spider had crept would be liable to get phenomena of a kind quite inexplicable, until he discovered the supernatural, *i. e.*, literally superphysical, cause. I will risk the assertion that life introduces something incalculable and purposeful amid the laws of physics; it thus distinctly supplements those laws, though it leaves them otherwise precisely as they were and obeys them all.

We see only its effect, we do not see life itself. Conversion of inorganic into organic is effected always by living organisms. The conversion under those conditions certainly occurs, and the process may be studied. Life appears necessary to the conversion, which clearly takes place under the guidance of life, though in itself it is a physical and chemical process. Many laboratory conversions take place under the guidance of life, and, but for the experimenter, would not have occurred.

Again, putrefaction, and fermentation, and purification of rivers, and disease, are not purely and solely chemical processes. Chemical processes they are, but they are initiated and conducted by living organisms. Just when medicine is becoming biological, and when the hope of making the tropical belt of the earth healthily habitable by energetic races is attracting the attention of people of power, philosophizing biologists should not attempt to give their science away to chemistry and physics. Sections D and H and I and K are not really subservient to A and B. Biology is an independent science, and it is served, not dominated, by chemistry and physics.

Scientific men are hostile to superstition, and rightly so, for a great many popular superstitions are both annoying and contemptible; yet occasionally the term may be wrongly applied to practises of which the theory is unknown. To a superficial observer some of the practises of biologists themselves must appear grossly superstitious. To combat malaria Sir Ronald Ross does not indeed erect an altar; no, he oils a pond—making libation to its presiding genii. What can be more ludicrous than

the curious and evidently savage ritual, insisted on by the United States officers, at that hygienically splendid achievement, the Panama Canal—the ritual of punching a hole in every discarded tin, with the object of keeping off disease! What more absurd, again—in superficial appearance—than the practise of burning or poisoning a soil to make it extra fertile!

Biologists in their proper field are splendid, and their work arouses keen interest and enthusiasm in all whom they guide into their domain. Most of them do their work by intense concentration, by narrowing down their scope, not by taking a wide survey or a comprehensive grasp. Suggestions of broader views and outlying fields of knowledge seem foreign to the intense worker, and he resents them. For his own purpose he wishes to ignore them, and practically he may be quite right. The folly of negation is not his, but belongs to those who misinterpret or misapply his utterances, and take him as a guide in a region where, for the time at least, he is a stranger. Not by such aid is the universe in its broader aspects to be apprehended. If people in general were better acquainted with science they would not make these mistakes. They would realize both the learning and the limitations, make use of the one and allow for the other, and not take the recipe of a practical worker for a formula wherewith to interpret the universe.

What appears to be quite certain is that there can be no terrestrial manifestation of life without matter. Hence naturally they say, or they approve such sayings as, "I discern in matter the promise and potency of all forms of life." Of all terrestrial manifestations of life, certainly. How else could it manifest itself save through matter? "I detect nothing in the organism but the laws of chemistry and physics," it is said. Very well; naturally enough. That is what they are after; they are studying the physical and chemical aspects or manifestations of life. But life itself—life and mind and consciousness—they are not studying, and they exclude them from their purview. Matter is what appeals to our senses here and now; materialism is appropriate to the material world; not as a philosophy, but as a working creed, as a proximate and immediate formula for guiding research. Everything beyond that belongs to another region, and must be reached by other methods. To explain the psychical in terms of physics and chemistry is simply impossible; hence there is a tendency to deny its existence, save as an epiphenomenon. But all such philosophizing is unjustified, and is really bad metaphysics.

So if ever in their enthusiasm scientific workers go too far and say that the things they exclude from study have no existence in the universe, we must appeal against them to direct experience. We ourselves are alive, we possess life and mind and consciousness, we have first-hand experience of these things quite apart from laboratory experiments. They belong to the common knowledge of the race. Births, deaths and marriages are not affairs of the biologist, but of humanity; they went on before a single one of them was understood, before a vestige of science existed. We ourselves are the laboratory in which men of science, psychologists and others, make experiments. They can formulate our processes of digestion, and the material concomitants of willing, of sensation, of thinking; but the hidden guiding entities they do not touch.

So also if any philosopher tells you that you do not exist, or that the external world does not exist, or that you are an automaton without free will, that all your

actions are determined by outside causes and that you are not responsible—or that a body can not move out of its place, or that Achilles can not catch a tortoise—then in all those cases appeal must be made to twelve average men, unsophisticated by special studies. There is always a danger of error in interpreting experience, or in drawing inferences from it; but in a matter of bare fact, based on our own first-hand experience, we are able to give a verdict. We may be mistaken as to the nature of what we see. Stars may look to us like bright specks in a dome, but the fact that we see them admits of no doubt. So also consciousness and will are realities of which we are directly aware, just as directly as we are of motion and force, just as clearly as we apprehend the philosophizing utterances of an agnostic. The process of seeing, the plain man does not understand; he does not recognize that it is a method of ethereal telegraphy; he knows nothing of the ether and its ripples, nor of the retina and its rods and cones, nor of nerve and brain processes; but he sees and he hears and he touches, and he wills and he thinks and is conscious. This is not an appeal to the mob as against the philosopher, it is appeal to the experience of untold ages as against the studies of a generation.

How consciousness became associated with matter, how life exerts guidance over chemical and physical forces, how mechanical motions are translated into sensations—all these things are puzzling and demand long study. But the fact that these things are so admits of no doubt; and difficulty of explanation is no argument against them. The blind man restored to sight had no opinion as to how he was healed, nor could he vouch for the moral character of the Healer, but he plainly knew that whereas he was blind now he saw. About that fact he was the best possible judge. So it is also with "this main miracle that thou art thou, with power on thine own act and on the world."

But although life and mind may be excluded from physiology, they are not excluded from science. Of course not. It is not reasonable to say that things necessarily elude investigation merely because we do not knock against them. Yet the mistake is sometimes made. The ether makes no appeal to sense, therefore some are beginning to say that it does not exist. Mind is occasionally put into the same predicament. Life is not detected in the laboratory, save in its physical and chemical manifestations; but we may have to admit that it guides processes, nevertheless. It may be called a catalytic agent.

To understand the action of life itself, the simplest plan is not to think of a microscopic organism, or any unfamiliar animal, but to make use of our own experience as living beings. Any positive instance serves to stem a comprehensive denial; and if the reality of mind and guidance and plan is denied because they make no appeal to sense, then think how the world would appear to an observer to whom the existence of men was unknown and undiscoverable, while yet all the laws and activities of nature went on as they do now.

Suppose, then, that *man* made no appeal to the senses of an observer of this planet. Suppose an outside observer could see all the events occurring in the world, save only that he could not see animals or men. He would describe what he saw much as we have to describe the activities initiated by life.

If he looked at the Firth of Forth, for instance, he would see piers arising in the water, beginning to sprout, reaching across in strange manner till they actually join or are joined by pieces attracted up from

below to complete the circuit (a solid circuit round the current). He would see a sort of bridge or filament thus constructed, from one shore to the other, and across this bridge insect-like things crawling and returning for no very obvious reason.

Or let him look at the Nile, and recognize the meritorious character of that river in promoting the growth of vegetation in the desert. Then let him see a kind of untoward crystallization growing across and beginning to dam the beneficent stream. Blocks fly to their places by some kind of polar forces; "we can not doubt" that it is by helio- or other tropism. There is no need to go outside the laws of mechanics and physics, there is no difficulty about supply of energy—none whatever—materials in tin cans are consumed which amply account for all the energy; and all the laws of physics are obeyed. The absence of any design, too, is manifest; for the effect of the structure is to flood an area up-stream which might have been useful, and to submerge a structure of some beauty; while down-stream its effect is likely to be worse, for it would block the course of the river and waste it on the desert, were it not that fortunately some leaks develop and a sufficient supply still goes down—goes down, in fact, more equably than before: so that the ultimate result is beneficial to vegetation, and simulates intention.

If told concerning either of these structures that an engineer, a designer in London, called Benjamin Baker, had anything to do with it, the idea would be preposterous. One conclusive argument is final against such a superstitious hypothesis—he is not there, and a thing plainly can not act where it is not. But although we, with our greater advantages, perceive that the right solution for such an observer would be the recognition of some unknown agency or agent, it must be admitted that an explanation in terms of a vague entity called vital force would be useless, and might be so worded as to be misleading; whereas a statement in terms of mechanics and physics could be clear and definite and true as far as it went, though it must necessarily be incomplete.

And note that what we observe, in such understood cases, is an *interaction* of mind and matter; not parallelism nor epiphenomenalism nor anything strained or difficult, but a straightforward utilization of the properties of matter and energy for purposes conceived in the mind, and executed by muscles guided by acts of will.

But, it will be said, this is unfair, for we *know* that there is design in the Forth Bridge or the Nile Dam, we have seen the plans and understand the agencies at work; we know that it was conceived and guided by life and mind; it is unfair to quote this as though it could simulate an automatic process.

Not at all, say the extreme school of biologists whom I am criticizing, or ought to say if they were consistent, there is nothing but chemistry and physics at work anywhere; and the mental activity apparently demonstrated by those structures is only an illusion, an epiphenomenon; the laws of chemistry and physics are supreme, and they are sufficient to account for everything!

Well, they account for things up to a point; they account in part for the color of a sunset, for the majesty of a mountain peak, for the glory of animate existence. But do they account for everything completely? Do they account for our own feeling of joy and exaltation, for our sense of beauty, for the manifest beauty existing throughout nature? Do not these things suggest something higher and nobler and more joyous, something for the sake of

which all the struggle for existence goes on?

Surely there must be a deeper meaning involved in natural objects. Orthodox explanations are only partial, though true as far as they go. When we examine each particolored pinnule in a peacock's tail, or hair in a zebra's hide, and realize that the varying shades on each are so placed as to contribute to the general design and pattern, it becomes exceedingly difficult to explain how this organized cooperation of parts, this harmonious distribution of pigment cells, has come about on merely mechanical principles. It would be as easy to explain the sprouting of the cantilevers of the Forth Bridge from its piers, or the flocking of the stones of the Nile Dam by chemiotaxis. Flowers attract insects for fertilization; and fruit tempts animals to eat it in order to carry seeds. But these explanations can not be final. We have still to explain the insects. So much beauty can not be necessary merely to attract their attention. We have further to explain this competitive striving towards life. Why do things struggle to exist? Surely the effort must have some significance, the development some aim. We thus reach the problem of existence itself, and the meaning of evolution.

The mechanism whereby existence entrenches itself is manifest, or at least has been to a large extent discovered. Natural selection is a *vera causa*, so far as it goes; but if so much beauty is necessary for insects, what about the beauty of a landscape or of clouds? What utilitarian object do those subserve? Beauty in general is not taken into account by science. Very well, that may be all right, but it exists, nevertheless. It is not my function to discuss it. No; but it is my function to remind you and myself that our studies do not exhaust the universe, and that if we dogmatize in a negative direction, and say that we can reduce everything to physics and chemistry, we gibbet ourselves as ludicrously narrow pedants, and are falling far short of the richness and fullness of our human birthright. How far preferable is the reverent attitude of the eastern poet:

> The world with eyes bent upon thy feet stands in awe with all its silent stars.

Superficially and physically we are very limited. Our sense organs are adapted to the observation of matter; and nothing else directly appeals to us. Our nerve-muscle system is adapted to the production of motion in matter, in desired ways; and nothing else in the material world can we accomplish. Our brain and nerve systems connect us with the rest of the physical world. Our senses give us information about the movements and arrangements of matter. Our muscles enable us to produce changes in those distributions. That is our equipment for human life; and human history is a record of what we have done with these parsimonious privileges.

Our brain, which by some means yet to be discovered connects us with the rest of the material world, has been thought partially to disconnect us from the mental and spiritual realm, to which we really belong, but from which for a time and for practical purposes we are isolated. Our common or social association with matter gives us certain opportunities and facilities, combined with obstacles and difficulties which are themselves opportunities for struggle and effort.

Through matter we become aware of each other, and can communicate with those of our fellows who have ideas sufficiently like our own for them to be stimulated into activity by a merely physical process set in action by ourselves. By a timed succession of vibratory movements (as in speech and music), or by a static

distribution of materials (as in writing, painting and sculpture), we can carry on intelligent intercourse with our fellows; and we get so used to these ingenious and roundabout methods, that we are apt to think of them and their like as not only the natural, but as the only possible modes of communication, and that anything more direct would disarrange the whole fabric of science.

It is clearly true that our bodies constitute the normal means of manifesting ourselves to each other while on the planet; and that if the physiological mechanism whereby we accomplish material acts is injured, the conveyance of our meaning and the display of our personality inevitably and correspondingly suffer.

So conspicuously is this the case that it has been possible to suppose that the communicating mechanism, formed and worked by us, is the whole of our existence: and that we are essentially nothing but the machinery by which we are known. We find the machinery utilizing nothing but well-known forms of energy, and subject to all the laws of chemistry and physics—it would be strange if it were not so—and from that fact we try to draw valid deductions as to our nature, and as to the impossibility of our existing apart from and independent of these temporary modes of material activity and manifestation. We so uniformly employ them, in our present circumstances, that we should be on our guard against deception due to this very uniformity. Material bodies are all that we have any control over, are all that we are experimentally aware of; anything that we can do with these is open to us; any conclusions we can draw about them may be legitimate and true. But to step outside their province and to deny the existence of any other region because we have no sense organ for its appreciation, or because (like the ether) it is too uniformly omnipresent for our ken, is to wrest our advantages and privileges from their proper use and apply them to our own misdirection.

But if we have learned from science that evolution is real, we have learned a great deal. I must not venture to philosophize, but certainly from the point of view of science evolution is a great reality. Surely evolution is not an illusion; surely the universe progresses in time. Time and space and matter are abstractions, but are none the less real; they are data given by experience; and time is the keystone of evolution.

> Thy centuries follow each other, perfecting a small wild flower.

We abstract from living moving reality a certain static aspect, and we call it matter; we abstract the element of progressiveness, and we call it time. When these two abstractions combine, cooperate, interact, we get reality again. It is like Poynting's theorem.

The only way to refute or confuse the theory of evolution is to introduce the subjectivity of time. That theory involves the reality of time, and it is in this sense that Professor Bergson uses the great phrase, "creative evolution."

I see the whole of material existence as a steady passage from past to future, only the single instant which we call the present being actual. The past is not non-existent, however; it is stored in our memories, there is a record of it in matter, and the present is based upon it; the future is the outcome of the present, and is the product of evolution.

Existence is like the output from a loom. The pattern, the design for the weaving, is in some sort "there" already; but whereas our looms are mere machines, once the guiding cards have been fed into them, the loom of time is complicated by a multitude

of free agents who can modify the web, making the product more beautiful or more ugly according as they are in harmony or disharmony with the general scheme. I venture to maintain that manifest imperfections are thus accounted for, and that *freedom* could be given on no other terms, nor at any less cost.

The ability thus to work for weal or woe is no illusion, it is a reality, a responsible power which conscious agents possess; wherefore the resulting fabric is not something preordained and inexorable, though by wide knowledge of character it may be inferred. Nothing is inexorable except the uniform progress of time; the cloth must be woven, but the pattern is not wholly fixed and mechanically calculable.

Where inorganic matter alone is concerned, there everything is determined. Wherever full consciousness has entered, new powers arise, and the faculties and desires of the conscious parts of the scheme have an effect upon the whole. It is not guided from outside, but from within; and the guiding power is immanent at every instant. Of this guiding power we are a small but not wholly insignificant portion.

That evolutionary progress is real is a doctrine of profound significance, and our efforts at social betterment are justified because we are a part of the scheme, a part that has become conscious, a part that realizes, dimly at any rate, what it is doing and what it is aiming at. Planning and aiming are therefore not absent from the whole, for we are a part of the whole, and are conscious of them in ourselves.

Either we are immortal beings or we are not. We may not know our destiny, but we must have a destiny of some sort. Those who make denials are just as likely to be wrong as those who make assertions: in fact, denials are assertions thrown into negative form. Scientific men are looked up to as authorities, and should be careful not to mislead. Science may not be able to reveal human destiny, but it certainly should not obscure it. Things are as they are, whether we find them out or not; and if we make rash and false statements, posterity will detect us—if posterity ever troubles its head about us. I am one of those who think that the methods of science are not so limited in their scope as has been thought: that they can be applied much more widely, and that the psychic region can be studied and brought under law too. Allow us anyhow to make the attempt. Give us a fair field. Let those who prefer the materialistic hypothesis by all means develop their thesis as far as they can; but let us try what we can do in the psychical region, and see which wins. Our methods are really the same as theirs—the subject-matter differs. Neither should abuse the other for making the attempt.

Whether such things as intuition and revelation ever occur is an open question. There are some who have reason to say that they do. They are, at any rate, not to be denied off-hand. In fact, it is always extremely difficult to deny *anything* of a general character, since evidence in its favor may be only hidden and not forthcoming, especially not forthcoming at any particular age of the world's history, or at any particular stage of individual mental development. Mysticism must have its place, though its relation to science has so far not been found. They have appeared disparate and disconnected, but there need be no hostility between them. Every kind of reality must be ascertained and dealt with by proper methods. If the voices of Socrates and of Joan of Arc represent real psychical experiences, they must belong to the intelligible universe.

Although I am speaking *ex cathedra,* as one of the representatives of orthodox sci-

ence, I will not shrink from a personal note summarizing the result on my own mind of thirty years' experience of psychical research, begun without predilection —indeed with the usual hostile prejudice. This is not the place to enter into details or to discuss facts scorned by orthodox science, but I can not help remembering that an utterance from this chair is no ephemeral production, for it remains to be criticized by generations yet unborn, whose knowledge must inevitably be fuller and wider than our own. Your president therefore should not be completely bound by the shackles of present-day orthodoxy, nor limited to beliefs fashionable at the time. In justice to myself and my co-workers I must risk annoying my present hearers, not only by leaving on record our conviction that occurrences now regarded as occult can be examined and reduced to order by the methods of science carefully and persistently applied, but by going further and saying, with the utmost brevity, that already the facts so examined have convinced me that memory and affection are not limited to that association with matter by which alone they can manifest themselves here and now, and that personality persists beyond bodily death. The evidence to my mind goes to prove that discarnate intelligence, under certain conditions, may interact with us on the material side, thus indirectly coming within our scientific ken; and that gradually we may hope to attain some understanding of the nature of a larger, perhaps ethereal, existence, and of the conditions regulating intercourse across the chasm. A body of responsible investigators has even now landed on the treacherous but promising shores of a new continent.

Yes, and there is more to say than that. The methods of science are not the only way, though they are our way, of arriving at truth.

Uno itinere non potest perveniri ad tam grande secretum.

Many scientific men still feel in pugnacious mood towards theology, because of the exaggerated dogmatism which our predecessors encountered and overcame in the past. They had to struggle for freedom to find truth in their own way; but the struggle was a miserable necessity, and has left some evil effects. And one of them is this lack of sympathy, this occasional hostility, to other more spiritual forms of truth. We can not really and seriously suppose that truth began to arrive on this planet a few centuries ago. The pre-scientific insight of genius—of poets and prophets and saints—was of supreme value, and the access of those inspired seers to the heart of the universe was profound. But the camp-followers, the scribes and pharisees, by whatever name they may be called, had no such insight, only a vicious or a foolish obstinacy; and the prophets of a new era were stoned.

Now at last we of the new era have been victorious; we inherit the fruits of the age-long conflict, and the stones are in our hands. Let us not fall into the old mistake of thinking that ours is the only way of exploring the multifarious depths of the universe, and that all others are worthless and mistaken. The universe is a larger thing than we have any conception of, and no one method of search will exhaust its treasures.

Men and brethren, we are trustees of the truth of the physical universe as scientifically explored: let us be faithful to our trust.

Genuine religion has its roots deep down in the heart of humanity and in the reality of things. It is not surprising that by our methods we fail to grasp it: the actions

of the Deity make no appeal to any special sense, only a universal appeal; and our methods are, as we know, incompetent to detect complete uniformity. There is a principle of relativity here, and unless we encounter flaw or jar or change, nothing in us responds; we are deaf and blind, therefore, to the immanent grandeur around us, unless we have insight enough to appreciate the whole, and to recognize in the woven fabric of existence, flowing steadily from the loom in an infinite progress towards perfection, the ever-growing garment of a transcendent God.

SUMMARY OF THE ARGUMENT

A marked feature of the present scientific era is the discovery of, and interest in, various kinds of atomism; so that continuity seems in danger of being lost sight of.

Another tendency is toward comprehensive negative generalizations from a limited point of view.

Another is to take refuge in rather vague forms of statement, and to shrink from closer examination of the puzzling and the obscure.

Another is to deny the existence of anything which makes no appeal to organs of sense, and no ready response to laboratory experiment.

Against these tendencies the author contends. He urges a belief in ultimate continuity as essential to science; he regards scientific concentration as an inadequate basis for philosophic generalization; he believes that obscure phenomena may be expressed simply if properly faced; and he points out that the non-appearance of anything perfectly uniform and omnipresent is only what should be expected, and is no argument against its real substantial existence.

Oliver Lodge

THE TEACHING OF COLLEGE BIOLOGY

In schools below college grade it is considered eminently desirable and necessary that the teacher shall have given some attention to the art of teaching. It is furthermore expected that he keep himself informed through meetings, reports, journals and discussions of progress in the art as well as the science he is expected to teach. He is expected to keep in touch with new ideas, in the subject matter and in the best methods of presenting them to his classes.

There appears to be a sharp distinction in this respect between these schools and colleges or universities. As a rule, college teachers are not expected to annoy themselves with principles of education or with methods of teaching. To do so is to ally oneself with prep. school ideas and associations. To be in open sympathy with any effort to arouse interest in the teaching side of one's profession is to lose caste with one's colleagues. Though primarily employed to teach, the consideration of one's specialty from the teaching standpoint is considered a necessary evil to be tolerated but not encouraged. Each new appointee is expected to adopt the university methods of his teacher or to stumble upon a plan which so frequently is a compromise between the limitations set by the institution and the bias of his training and experience, with little or no regard for the real needs of the student.

Very slowly there has developed a growing consciousness that the plans and methods that served so admirably during the last generation no longer met the needs of the college man or woman of the present day, particularly in the natural sciences. And the opinion has frequently been expressed that an exchange of ideas and experiences by men from different colleges or universities of the country would tend to clear the ground for an understanding of the nature and scope of the biology courses in schools of college grade. It was felt that the first effort should be directed toward a study of the introductory course in biology, the only one that the great majority of college students ever take.

During the summer of 1911 a number of biologists[1] met at Woods Hole, Mass., to discuss the nature and scope of the first year's or introductory course in the natural sciences in schools of college grade. It was agreed that very profound changes in the preparation of the student, in educational policies, in the attitude of the student and the public toward the science, and the great progress in the science itself, made it imperative that the college course be correspondingly modified in the light of these changes. It was also agreed that narrow standardization or uniformity was impossible.

The courses as outlined by each person present made it very evident that there was considerable agreement in certain fundamental principles and tendencies, namely: (1) a tendency away from the narrow study of comparative morphology; (2) a tendency to include fewer types, studied from a wider viewpoint; (3) a tendency to emphasize the study of living organisms in relation to their environment; (4) a tendency to emphasize physiological processes; (5) to include the consideration of the relation of living organisms to man; (6) to include the consideration of general and fundamental phenomena, and some of the big problems that biologists are endeavoring to solve.

Unfortunately time did not permit an adequate discussion of what appears to the writer to be a very important phase of the problem, namely, to what extent should the student be made to realize the methods used in the investigation of biologic phenomena, and the nature of the value of biologic evidence. It would be extremely useful if Professors Conklin, Calkins, Lefevre, McClung and others present at the meeting could be persuaded to make their plans and experiences public.

[1] The men present were: Professors Calkins of Columbia, Conklin of Princeton, Goldfarb of the College of the City of New York, Kellicott of Goucher College, Knower of Cincinnati, Lefevre of Missouri, Lewis of Wisconsin, McClung of Pennsylvania, Montgomery (who recently died), Moore of Washington University (St. Louis), Parker of Harvard, Patterson of Texas, Pike of Columbia.

The results of the meeting suggested the desirability of obtaining certain data from a larger number of institutions, in the belief that they might serve as a basis for a more general and open discussion of a difficult and important problem. Fully conscious of the limitations of such tabulated data, they are nevertheless submitted, as obtained from over fifty colleges and universities. Over ten, not included in the tables to follow, were so incomplete as to make their inclusion of very questionable value. By request, the names of the contributors are not mentioned. I wish to express my thanks to all who so kindly cooperated in furnishing the data called for.

OPTIONAL OR REQUIRED INTRODUCTORY BIOLOGY

The term biology is here used in a very loose sense to mean any introductory course in the natural sciences offered in colleges.

Number of Colleges	
40	Biology is required at least of certain groups of students.
4	Biology is not required, optional only.
1	Biology is not offered at all, except one term of elementary physiology.

Number of Colleges	Length of Course	
5	one half year	Required
33	one year	Required
4	one year	Optional
1	two years	Required
1	three years	Required

PROPORTION OF THE STUDENT BODY WHO TAKE INTRODUCTORY BIOLOGY

A very small part of the student body take or have taken this introductory course, as shown by the following table:

No. of Colleges	Per Cent. Students
2	100
1	90
3	50
9	33
2	20
14	10
2	2½
7	*

* Doubtful.

STUDENTS IN INTRODUCTORY COURSE GROUPED ACCORDING TO THEIR OFFICIAL CLASSES

Per cent. of class who take the biology	100	90	80	70	60	50	40	30	20	10	0
	Number of Colleges										
Freshmen	0	3	2	3	5	7	3	1	3	2	10
Sophomores	0	0	1	1	3	4	2	4	11	7	6
Juniors	0	0	1	1	2	1	2	1	5	15	11
Seniors	0	0	0	0	0	0	1	3	2	12	21
Freshmen and Sophomores	4	6	10	6	5	0	2	0	2	1	3
Juniors and Seniors	2	1	1	1	0	1	3	8	10	6	6

It is perfectly clear that so far as these colleges are concerned the great majority, *i. e.*, 30 to 100 per cent., of the classes in introductory biology are freshmen and sophomores, and that 0 to 30 per cent. are from the junior and senior classes. The presumption, of course, is that the course is adapted to the needs of the lower class men and not to advanced or university students.

DATA CONCERNING THE SUBJECT MATTER OF THE COURSE

1. The nature of the introductory course in the different colleges is given in the following tables.

> Invertebrate zoology in 3 colleges.
> Vertebrate zoology in 0 college.
> Zoology (vertebrate and invertebrate) in 23 colleges.
> Animal and plant (biology) in 16 colleges.
> Botany in 2 colleges.

In a few colleges the student is permitted to choose between a year's course either in zoology or in botany.

2. The character of the course is to some extent indicated by the kind and number of "types" used. The returns show that the *one type course*, somewhat like Huxley's crayfish, is not used in any college; the *few type course*, like the Sedgwick and Wilson biology, is used in 11 colleges; the *many type course*, like the Parker and Haswell zoology, is used in 28 colleges. A distinct modification of the last kind of course consists in greatly emphasizing one, usually a vertebrate organism, and studying other types in less detail, and fewer in number. Seven colleges adopted this kind of course.

The following table gives an idea of the number of types used in different colleges.

ZOOLOGY COURSE

Number of Types	Number of Colleges
15	2
14	1
13	0
12	5
11	5
10	9
9	5
8	5
7	2
6	4
5	1
	Total 23 colleges

PLANT AND ANIMAL COURSE

Number of Animal Types	Number of Plant Types	Number of Colleges	Total Number of Types
10	4	1	14
8	4	1	
9	3	1	12
7	5	1	
7	4	2	11
7	3	1	
6	4	1	10
5	5	3	
8	1	1	
5	4	1	9
3	6	1	
3	4	1	7
2	4	1	6
		Total 16 colleges	

These tables clearly show the preponderance of the zoologist and of zoological types, even in so-called biology courses. They also indicate the significant departure from the study of a representative type from each phylum, in the direction of limiting the number except in courses mistakenly designed to prepare students for medicine.

In the following table the zoologic types are grouped according to their frequency:

	Colleges
Protozoan type used in	38
Cœlenterate	37
Annelid	36
Crustacea	33
Amphibia	31
Insecta	25
Mollusc	22
Echinoderm	19
Flat worm	16
Fish	13
Sponge	12
Mammal	11
Embryology	8
Round worm	4
Bird	3
Reptile	3
Man	1

This table also shows that there is a distinct tendency not to include in the course a type from each phylum. It is far more significant as indicating the choice of types that are believed to have the greatest teaching value, as judged by teachers in different colleges. The first half of the table includes the types that will probably be chosen more and more for the kind of course under discussion.

When the botanical types are grouped according to their frequency in the sixteen colleges, it is found that the

Fern is used in 13 colleges,
Yeast in 11 colleges,
Algæ in 11 colleges,
Flowering plants in 9 colleges,
Fungi in 8 colleges,
One-celled plants other than the above in 3 colleges,
Fern and lower plants only in 5 colleges.

This table shows that plant phenomena are taught in most of the colleges from representatives of all the main plant groups, namely, bacteria, algæ, fungi, ferns and flowering plants, that economically important plants are given splendid recognition. This distribution of types stands in marked contrast to the zoologic courses in which invertebrate types predominate.

It may be interesting to note that only seventeen colleges used the well-known ascending or evolutionary order in the study of the types, three colleges used the descending or so-called pedagogic order, *i. e.*, from organisms best known to the student to those least known, or those whose study involves the greatest technical difficulties. In fourteen colleges an introductory type is studied intensively to acquaint the student with biologic apparatus and methods, and to afford a basis for comparison with subsequent types. The ascending order in most colleges follows this introductory type. In four colleges only the type method of instruction is not used at all, as splendidly illustrated in Needham's book.

TIME IN HOURS DEVOTED TO THE COURSE

There is an extremely wide range in time and in the distribution of the time to lecture, recitation, laboratory and field work. The following tables give the detailed information.

Hours per Week	Number of Colleges
FOR ONE YEAR	
11	1
10	3
9	1
8	1
7	4
6	10
5	7
4	6
FOR ONE HALF YEAR	
8	1
5	1
4	1
3	2

Far more significant than the mere fact that most colleges provide four to six hours per week for one year, which arrangement seems to be the one more and more in vogue, are the facts shown in the next table, which gives the time devoted to lecture, recitation and laboratory.

Hours per week	0	*	½	1	2	3	4	5	6	7	8	9
To lecture	0	2	3	13	19	4	0	0	0	0	0	0
To recitations	9	7	4	18	2	0	1	0	0	0	0	0
To laboratory	0	0	0	0	13	10	8	2	4	0	3	1

* Occasional.

It will be observed that in several colleges as much time is given to lecturing about things as to the study of the things them-

selves. In eighteen colleges two hours a week are spent in lectures and two hours a week in the laboratory; in three colleges three hours are devoted to lectures and the same time to laboratory. This is a regrettable survival of the so-called German university system.

In four colleges no recitation or quiz is given at all. In thirteen only an occasional recitation is held; in three colleges not more than a half hour, either each week or at various intervals, but not extending beyond this time.

The following table supplements the above and brings out in sharp relief the over-emphasis of the lecture and the very inadequate attention to the recitation.

Number of Hours in			Number of
Lecture	Recitation	Laboratory	Colleges
1	1	2	2
½	½	2	2
1	1	3	2
1	1	4	5
1	1	5	1
1	1	6	2
1	2	8	1
2	0	2½	5
2	*	3	4
2	1	2	2
2	0	4	1
2	1	4	2
2–3	0–1	5–9	1
2	0	6	1
2	0	8	1
2	1	8	1
3	0	3	1
3	½	3	2
3	1	6	1
3		2	2
½	2	5	1
few	4	3	1

* Occasional.

The following table gives an idea of the frequency that certain topics are considered in the course, either in the laboratory lecture, essays or assigned readings.

32 colleges, the theory of evolution.
31 colleges, heredity.
29 colleges, comparative anatomy of invertebrates.
24 colleges, comparative anatomy of vertebrates.
22 colleges, histology.
21 colleges, bacteriology and sanitation.
19 colleges, botany.
15 colleges, experimental zoology.
15 colleges, experimental embryology.
13 colleges, paleontology.

There are twenty-five colleges that treat of the economic or applied biology, eighteen of which treat this phase of the course in lectures only, four in lectures and laboratory, three in lectures, laboratory and practical or field work. Four colleges do not include economic aspects of the science in the course.

I had hoped to obtain information with reference to the manner and the extent to which this aspect of the problem was considered. But the returns did not lend themselves to tabulation.

ARTICULATION WITH SECONDARY SCHOOL BIOLOGY

In the College of the City of New York the students in the introductory course include those who have not had a high-school course in biology and those who have had such a course. It has been our experience that the one group is not appreciably better informed or better equipped to attack the subject, nor do they appear to do any better than the other group of students. It is not my purpose to make any reflection upon the excellent work done by exceedingly able and conscientous teachers in the high schools. I merely wish to state that, so far as our experience goes, it is altogether probable that the college course may safely ignore any training or equipment based upon the high-school course in biology. Furthermore, since every tendency indicates a continued independence of the high-school courses from the domination or educational policies of colleges and universities, it seems safe to conclude that any articulation with the high schools is inadvisable.

BIOLOGY TEACHING IN COLLEGES

It is now generally agreed that every college man or woman should have had at least one year's college biology. This plan is now adopted in nearly all colleges. It is also agreed that in order to reach the larger body of students and to make possible later special-

ization that the introductory course should be offered as early in the college curriculum as possible.

Since an exceedingly small proportion of the students continue the study of biology, namely, those preparing for medicine or teaching, and since the great majority leave college without any further training or acquaintance with the subject, the opinion seems to prevail that the introductory course should be a rounded one, that it should give a first-hand acquaintance with *living organisms*, in relation to their environment, an adequate idea of the larger and fundamental problems of the biologist and, above all, an idea of the general methods used in biologic investigations.

While there is considerable range of opinion with respect to the time required for the course, there is an undoubted tendency to limit the course to five or six hours a week for one academic year.

Upon the broad lines just suggested there is a general agreement, beyond these there is a healthy divergence of opinion, particularly upon the nature and the content of the course. There has been an undoubted tendency away from the narrow study of comparative morphology, the standard course of a generation ago, toward an increasing emphasis upon an adequate understanding of fundamental biologic phenomena, as we understand the term to-day, of the unit of the organism, the cell, the organism, and the fundamental processes characteristic of living things in general. To give such a course it has been found increasingly expedient to study representatives of animal and plant kingdoms. There are very many eminent teachers who believe that, on account of practical difficulties, it were better to use animal organisms only and to develop the fundamental properties of living things from zoologic types only. But these teachers are in nearly every instance zoologists.

The chief kinds of courses show considerable variation. There are courses like the almost abandoned narrow comparative morphology, others in which attention is directed to the functioning of the mechanisms studied and others in which the emphasis is placed upon the laws which living things obey, and only sufficient attention given to the structures involved as will make the understanding of these laws possible. Professor Kofoid's course, as I understand it, is one such course. This idea carried to its extreme is illustrated in courses that follow more or less closely the Jordan and Kellogg evolution book. Where the endeavor is to offer an abbreviated course usually covering one semester and to give the student an idea of fundamental principles a course somewhat along the lines of Sedgwick and Wilson's biology is followed. Professor Needham's course in biology is too well known to need extended comment. It is another fine contribution and merits further trial.

There can be no question but that the trend of thought is in the direction of giving the student a rounded and definite view of the world of living things, that the student who pursues the subject no further may carry with him an adequate knowledge of the world of living beings, and that the student who intends to make a more intensive study of the biologic sciences may have a sufficient background for the choice of his electives as his interest or needs may demand.

With a changed viewpoint in the matter of the scope of the course has come an increasing appreciation of the value of the study of *living things*. They are no longer thought unworthy of serious study, to be left to teachers of kindergartens and elementary schools. It is no longer deemed necessary to depend exclusively upon foul-smelling, often distorted and discolored preserved specimens for an understanding of a living organism. At the last meeting of the representatives of the colleges of the Middle States and Maryland there was a wholesome and surprising agreement on the important place that living organisms should hold in our biologic courses.

With an appreciation of the desirability of studying living organisms the importance of local or well-known forms has become apparent. The choice of a type has unfortunately been too frequently determined by the

author of the laboratory guide book, rather than the needs of the student. Where there is a choice between two forms that are equally good in developing the ideas of structure or physiological processes, the local or more generally known form should always be preferred. Obvious as this may appear, there are a number of instances where exotic or marine forms are used where fresh-water local specimens are available.

The data submitted showed that there was a very wide range in the time given to the course, that there was nevertheless a tendency to limit the number of hours to five or six a week for one year. Whatever the number of hours may be, there is, in so many colleges, an undue importance placed upon the value of lectures as against the value of self-expression either in the laboratory or in the recitation. If our message is to study nature, not books, even if it appears necessary to study nature through the artificial medium of the laboratory, as much time should be given to the study of organisms at first hand as circumstances warrant. It is exceedingly difficult to state what proportion of the time should be spent in the lecture, laboratory and recitation. It is easier to state what is wrong than what is right. It seems to the writer at least that two hours in the lecture room and two hours in the laboratory placed a disproportionate emphasis upon a knowledge about, rather than of, nature. Yet in twelve colleges this is the situation.

Even more surprising is the lack of appreciation of the value of the recitation in such an introductory course. In nine colleges, for example, no opportunity is offered for self-expression on the part of the student, or for determining how far the student has grasped the ideas, or to what extent the course is adapted to the needs of the particular group of students, but more important even than these is the opportunity offered by the properly conducted recitation to let the student appreciate the method of scientific thinking and the numberless unanswered problems that the biologist is wrestling with. In seven colleges only occasional recitations are held; in four colleges the recitations extend not more than a half hour a week.

It is to be hoped that the reserve that has so long prompted many excellent teachers and biologists to withhold from their colleagues the results of their many years of experimentation and thought upon the teaching of introductory biology, may be set aside and that appropriate means be found for an exchange of experiences. If arousing and developing a wholesome interest in biology is an important part of our duties in the colleges or universities, should we not cooperate in aiding one another in this important work. At worst, we can agree to differ.

A. J. Goldfarb
College of the City of New York

MEXICAN ARCHEOLOGY AND ETHNOLOGY

A greater impetus will be given to the International School of American Archeology and Ethnology in the city of Mexico in this, the fourth year of its existence. The members have been added to and the fund for its use will be increased so as to permit of larger activities and explorations. The school was founded in 1910 by the governments of Mexico and Prussia, Columbia University, Harvard University, the University of Pennsylvania and the Hispano Society of America, under the initiative of Columbia. In the second year of the school the government of Russia, through the Imperial Academy of Sciences, and the government of Bavaria, joined the school, and in the third year the government of Austria and the city of Leipsic, through its ethnological museum, joined it. During the first year the budget of the school, including salaries and fellowships, amounted to $6,000, in the second and third years to $10,000 each, and in the coming year it will be $12,000, of which amount Mexico contributes $3,000 and two $500 fellowships. No elementary or popular instruction is given in the school, but opportunity is offered to advanced students to familiarize themselves with the problems of Mexican archeology and ethnology, and to understand researches in these fields. The objects collected by the school are

placed at the disposal of the National Museum of Mexico, to make such selections as it thinks desirable and the remainder becomes the property of the patrons of the school. The first director of the school was Professor Edward Seler, of Berlin, appointed by Prussia; the second was Professor Franz Boas, of New York, appointed by Columbia; the third was Professor Jorge Engerrand, of Mexico, appointed by Mexico, and the fourth will be Professor A. M. Tozzer, appointed by Harvard.

It has been the endeavor of the successive directors to organize the work of the school in such a way as to concentrate the energies of the school on a few carefully selected tasks. Professor Seler undertook an investigation of the ruins of Palenque and of some of the less-known ruins of Yucatan, and, after the completion of this work, inaugurated investigations on the archeological types of the valley of Mexico. In the same year Professor Boas devoted some time to linguistic studies on the dialects of the Nahua. In the second year the archeological studies in the valley of Mexico were continued, and a series of stratigraphical examinations of sites was undertaken. These led to the discovery of a regular sequence of three cultural types, the presence of which was known before, although their relative ages had not been determined, and pointed out the need of extended stratigraphical investigations in the valley of Mexico. Remains were found deep below the level of the lakes of the valley of Mexico, showing the great antiquity of the various types of culture. On the hills, sites were discovered in which the oldest type of culture appeared on the surface. The investigation of the dialects of Mexico was continued, particularly through studies on the southern dialects of the Nahua. Studies on Mexican folklore were also taken up, which yielded the most abundant and interesting results, suggesting the most curious interrelations between the folklore of Spain, Africa and America, and suggesting a much more important influence of Spanish folklore upon American tradition than has generally been assumed to exist. In the third year, Professor Engerrand continued similar lines of work. Under his direction the stratigraphical work was continued on a large scale in the valley of Mexico, and yielded most interesting results, clearing up still further the historical relation between the three cultural types. A comparative study was also made in the state of Colima. One of the fellows of the school who worked under his direction made a large folkloristic collection in Oaxaca, and studied the Huave, one of the isolated languages of that area, which he proved to be related to the Mixe. Another fellow continued his studies on the language, religion and folklore of the Tepecanos, a Pima tribe in northern Jalisco. The importance of the stratigraphical work conducted by the school has proved so great that the Geological Institute of Mexico is now continuing this enterprise on a large scale by means of borings. During the coming year, under the direction of Professor Tozzer, the stratigraphical work in the valley of Mexico will be continued, and the study of folklore will receive particular attention. The studies on the Nahua dialects will also be continued.

THE AMERICAN FISHERIES SOCIETY

The forty-third annual meeting of the American Fisheries Society was held in Boston from September 8 to 11 under the presidency of Dr. C. H. Townsend, of the New York Aquarium. Dr. Henry B. Ward, of the University of Illinois, was vice-president, and the vice-presidents of divisions were as follows: Fish Culture, James Nevin, Madison, Wis.; Aquatic Biology and Physics, L. L. Dyche, Pratt, Kan.; Commercial Fishing, W. J. Hunsaker, Saginaw, Mich.; Angling, H. Wheeler Perce, Chicago, Ill.; Protection and Legislation, Dr. T. S. Palmer, Washington, D. C. The program of scientific papers was as follows:

William P. Seal: "Suggestions of possible Interest to the American Fisheries Society and to Fish Commissions."

Dr. C. H. Townsend, director, New York Aquarium: "The Private Fish Pond—a neglected resource." Recent Progress in Oceanography.

F. F. Dimick, secretary, Boston Fish Bureau: "The Fish Trade Organizations."

Dr. H. M. Smith, commissioner, U. S. Bureau of Fisheries: "The Need for a National Institution for the Technical Instruction of Fisherfolk."

L. L. Dyche, state fish and game warden, Kansas: "One Year's Work at the Kansas Fish Hatchery," "The Possibilities of an Acre Fish Pond."

Jacob Reighard: "A Plea for the Preservation of Records concerning Fish," "Improvement of Fishing through a Knowledge of the Breeding Habits of Fish."

Phil C. Zalsman: "Experiments in Fish Culture while in the Employment of the Michigan and Wisconsin Fish Commissions."

Charles H. Nerley: "Small Mouth Black Bass."

J. P. Snyder: "Notes on Striped Bass."

J. T. Nichols: "Concerning Young Bluefish."

Dr. George W. Field, chairman, Massachusetts Fish and Game Commission: "The Alewife Fishery of Massachusetts."

Dr. T. H. Bean, state fish culturist, New York: "The Rearing of Small-mouthed Black Bass."

N. R. Buller, commissioner, Pennsylvania Fisheries Department: "The Work of the Pennsylvania Fisheries Department."

Charles G. Atkins, superintendent, U. S. Fisheries Station, Craig Brook, Maine: "The Atlantic Salmon."

Dr. Irving H. Field, Clark University, Worcester, Massachusetts: "The Development of the Salt Water Mussel Industry."

Professor Henry B. Ward, Urbana, Illinois: "Fish Refuges."

W. E. Meehan, director, Philadelphia Aquarium: "The Establishment of an Aquarium in Philadelphia."

Professor E. E. Prince: "Some Animals and Conditions Inimical to Fish Eggs and Larvæ in the Sea," "A Perfect Fish Pass; Some Suggestions as to Defects in Fish Passes and How to Overcome Them."

Henry C. Rowe, president, Oyster Growers and Dealers Association of North America: "The Oyster Industry."

David L. Belding, biologist, Massachusetts Fish and Game Commission: "Conditions Influencing the Growth of Clams (*Myra arenaria*)."

Professor G. H. Parker, Harvard University: "The Senses of Fishes."

The next annual meeting will be held in New Orleans beginning on September 30, 1914.

CHEMISTRY AT THE ATLANTA MEETING OF THE AMERICAN ASSOCIATION

AT the meeting of the American Association for the Advancement of Science to be held in Atlanta, it is planned to hold sessions of Section C (Chemistry), of which no sessions were held at Cleveland in 1912. The general idea is to endeavor to have before Section C papers on chemical topics of wide and general interest, especially to workers in other branches of science and to laymen, leaving to the American Chemical Society the field which they already occupy, namely, the presentation of chemical papers to and for chemists. In pursuance of this plan it is proposed to have some short addresses, each of which will either deal with some general topic or be of the nature of reports of recent progress in some of the large branches of the subject of chemistry. A second day may, if it prove desirable and practicable, be devoted to a joint meeting of Section C with the local sections of the American Chemical Society, in which case papers dealing with more special subjects would be read. The secretary of Section C is Dr. John Johnston, Geophysical Laboratory, Washington, D. C.

SCIENTIFIC NOTES AND NEWS

THE University of Birmingham on September 11 conferred its doctorate of laws on the following foreign representatives in attendance at the meeting of the British Association: Madame Curie (Sorbonne, Paris), Professor H. A. Lorentz (Leyden), Professor Keibel (Freiburg), Professor R. W. Wood (Johns Hopkins) and Professor Svante Arrhenius (Stockholm).

THE evening discourses at the Birmingham meeting of the British Association were given by Sir Henry Cunynghame, of the Home Office, on "Coal Dust Explosions and the Means of Preventing Them," and by Dr. Smith Woodward, F.R.S., of the British Museum, on "Missing Links among Extinct Animals."

DR. WILHELM OSTWALD, the distinguished physical chemist and philosopher, celebrated his sixtieth birthday on September 2.

DR. G. S. FULLERTON, professor of philosophy at Columbia University and exchange professor with Austria, will lecture at Vienna six weeks in the autumn and six weeks in the spring. He will lecture also at Graz and Innsbruck.

THE Walker prizes in natural history of the Boston Society of Natural History have been awarded this year as follows: the first prize, amounting to $100, to Dr. Reynold A. Spaeth, for his essay on "An Experimental Study Concerning the Chromatophores of Fishes," and the second prize of $50 to Professor O. D. Von Engeln, for his essay on the "Effects of Continental Glaciation on Agriculture." Prizes for 1914 and 1915 will be awarded for original and unpublished research work in any biological or geological subject. The memoirs must be in the hands of the secretary on or before April 1.

THE University of Munich has awarded a prize of 3,000 Marks to Dr. Joseph Golling for his research entitled anthropological investigations on the bones of the nose in man.

PROFESSOR NEUBERG has been appointed a demonstrator in the chemistry division of the Kaiser Wilhelm Institute for Experimental Therapy in Dahlem, near Berlin.

DR. R. LÖWENHERZ, docent for chemistry at Königsberg, has been appointed curator of the chemical museum of the Berlin Technological Institute.

PROFESSOR A. KOLB, of the Technical Institute of Darmstadt, has retired to engage in industrial chemical work in Berlin.

MR. H. L. VIERECK, formerly with the Bureau of Entomology at Washington, is at present working with the Minnesota state entomologist, Professor F. L. Washburn.

THE annual meeting of the Association of Military Surgeons of the United States was held in Denver, Colo., September 16–19, under the presidency of Surgeon W. C. Braisted, U.S.N.

AT the twenty-third annual meeting of the American Electrotherapeutic Association, held in New York on September 2, 3 and 4, the following officers were elected: president, Dr. George E. Pfahler, of Philadelphia; vice-presidents, Dr. Albert C. Geyser, of New York, Dr. Frank B. Granger, of Boston, Dr. John D. Torbett, of Marlin, Texas, Dr. William L. Clark, of Philadelphia, and Dr. Frederick P. Tice, of Roanoke, Va.

PRESIDENT SCHURMAN, who has been on leave of absence from Cornell University for the past year, representing the United States at Athens as minister to Greece, has returned to the university.

PROFESSOR B. K. EMERSON, owing to an injury to his knee, will be unable to conduct the New England Intercollegiate Geological Excursion which was planned for the vicinity of Dalton, Mass., and consequently the meeting will not be held this year.

WE learn from *Nature* that a ship has been purchased for an Austrian expedition to the South Polar regions, and that funds are being collected in aid of the object. The expedition is to be under the leadership of Dr. F. König, of Graz, and the proposal is that it shall leave Trieste in May next. A large donation to the funds has been given by the Vienna Academy of Science, and the Austrian Geographical Society has promised an annual subsidy.

THE Philadelphia Alumni Society of the medical department of the University of Pennsylvania has issued an appeal for funds to endow a scholarship which it is planned to establish in memory of the late Dr. Roland G. Curtin.

KING GEORGE received recently at Buckingham Palace the members of the Scott Expedition and presented them with the antarctic medal and clasp. He also presented Lady Scott, Mrs. Wilson, Mrs. Evans and Mrs. Brissenden with the medal and clasps which had been awarded to their late husbands, and to Mrs. Bowers the medal and clasp awarded to her son, the late Lieut. H. R. Bowers. At the request of the late Captain Oates's mother, the medal and clasp awarded to her son were received on her behalf by Commander Evans.

A MEMORIAL to the lost Russian explorer, Baron E. von Toll, is to be set up on the west

coast of Kotelnyi Island, in the New Siberia group—the starting-point of the explorer and his companions on their last journey.

Professor John Milne has left his books, albums and scientific instruments relating to seismology to the British Association; and subject to his wife's interest £1,000 to the chairman of the seismology committee of the association, for the study of earth physics.

Dr. Alexander Macfarlane, formerly instructor in physics in Edinburgh University and professor of physics in the University of Texas, recently residing in Chatham, Ontario, known for his contributions to vector analysis and quaternions, died on August 28, aged sixty-two years.

Dr. Hugh Marshall, F.R.S., professor of chemistry in University College, Dundee, died on September 6, aged forty-five years.

Dr. George Friedrich Kinkelin, the geologist of the Frankfort Senckenberg Natural History Society, has died at the age of seventy-eight years.

Dr. Bernhard Bardenhauer, professor of surgery at Cologne, has died at the age of seventy-three years.

Dr. Wilhelm Muthmann, professor of chemistry in the Technical School at Munich, known for his work on the rare earths, has died at the age of fifty-two years.

Dr. Friedrich Seiler, professor of pharmaceutical chemistry at Lausanne, has died at the age of fifty years.

Dr. O. M. Reuter, emeritus professor of zoology in the University of Helsingfors, died on September 2, at the age of sixty-three years.

Columbia University opened its 160th academic year on September 24, when Professor James F. Kemp, head of the department of geology, made the address, his subject being "The Appeal of the Natural Sciences."

The sum of 90,000 francs has been bequeathed to the Pasteur Institute at Paris for the founding of a prize for the best original work in the treatment of meningitis.

The sixth annual meeting of the Association of Official Seed Analysts will be held in Washington, D. C., November 14 and 15, at the time of the meetings of the Agricultural Group of Societies.

The Prussian ministry of education, which a short time ago made grants of money to the university clinics at Berlin, Halle and Kiel, enabling them to procure radium or mesothorium for the treatment of cancer, is now said to have placed $200,000 in the estimates of next year for further purchases.

It is stated that the Maharaja Scindia of Gwalior is giving special attention to the archeological relics and treasures in his state, and is taking steps to create an archeological department in Gwalior. In furtherance of this object he has sought the advice and cooperation of the director-general of archeology in India.

Lord Murray, of Elibank, has concluded with the government of Ecuador a contract for the development of the oil resources of the republic. Under this contract Lord Murray undertakes to spend £100,000 within ten years in exploring for oil in Ecuador. Work is to begin within a year of the publication of the proposed law, and competent geologists and engineers are to be employed who are to supply the government with detailed maps of the country they survey and to keep the government specially informed as to discoveries of artesian water.

A further grant of £5,000, making £10,000 in all, has been made by the federal government of the commonwealth of Australia towards completing the work of the Mawson Antarctic Expedition and bringing the explorers back.

The *Journal* of the American Medical Association says that the initiative of the medical profession of Philadelphia and Pennsylvania has brought into legal existence large new institutions that will bring the city and state well into the advance along social lines: Mentally defective women of childbearing age, of whom at least 15,000 are known to be within the state, will now be permanently segregated in a great farm colony in a remote mountain forest reserve, thus preventing further multi-

plication. A home for alcohol and drug habitués, long agitated, is provided for in another forest reserve as, elsewhere, is an industrial home for women.

IT is stated in *Nature* that the Italian archeological mission to Crete, under the leadership of Professor Halbherr, announces the discovery at Cortina of a temple dedicated to Egyptian deities, bearing the dedication by Flavia Philyra, the foundress. In the inner cella were found images of Jupiter, Serapis, Isis and Mercury, with fragments of a colossal statue, supposed to be that of the foundress. A little flight of steps leads down to a subterranean chamber in which ceremonies of purification were performed. The excavation of the numerous prehistoric sites in the island of Malta is being actively prosecuted under the direction of Professor T. Zammit. The most important discovery is that of a series of well tombs of the Punic type at the Kallilia plateau, northwest of Rabat. A large number of skeletons, with pottery, lamps, spindle-whorls and a circular bronze mirror, has been unearthed. A partial exploration of the Ghar Dalam cave, conducted by Professor Tagliaferro and Mr. C. Rizzo, produced bones of a hippopotamus and a deer, above which lay a quantity of prehistoric sherds. The museum, by the bequest of the late Mr. Parnis, has received a large collection of books about Malta and numerous antique objects.

UNIVERSITY AND EDUCATIONAL NEWS

IT is announced that the scheme for the establishment of a school of tropical medicine in Calcutta is now so far advanced towards fulfilment that there is every reason to hope that it will be opened in the autumn of next year.

PROFESSOR ALEXANDER T. ORMOND has resigned the McCosh professorship of philosophy at Princeton University to accept the presidency of Grove City College.

PROFESSOR ALEXANDER SMITH, head of the department of chemistry in Columbia University, who has been elected professor of chemistry at Princeton University, will not assume his new duties until the academic year 1914–1915.

THE vacancy created at Vassar College by the resignation of Professor Clark Wells Chamberlain, in order to take the presidency of Denison University, has not been filled; Associate Professor Edna Carter will act as head of the department of physics for the present year.

AT Lehigh University the following promotions in the faculty are announced: George C. Beck, to be assistant professor of quantitative analysis; Sylvanus A. Becker, assistant professor of civil engineering; Joseph B. Reynolds, assistant professor of mathematics and astronomy; Rollin L. Charles, assistant professor of physics; Stanley J. Thomas, instructor in biology. The following appointments have been made: Ferdinand F. Hintze, assistant professor of geology; Siegfried Fischer, instructor in metallurgy; Wallace G. Matteson, instructor in geology; Edgar C. Weinsheimer, instructor in geology; M. S. Knebelman, instructor in mathematics; James B. Arthur, instructor in electrical engineering.

AT Rutgers College Stanley E. Brasefield, Ph.D. (Cornell), and William Beverly Stone, Ph.D. (Univ. of Va.), have been appointed assistant professors of mathematics.

L. C. PLANT, who has been at the head of the department of mathematics in the University of Montana for the past six years, has resigned, to accept the position of head of the department of mathematics in the Michigan Agricultural College. He has been succeeded by Dr. N. J. Lennes, of the department of mathematics of Columbia University.

DR. WALTER KRUSE, of Bonn, has been appointed professor of hygiene at Leipzig.

DISCUSSION AND CORRESPONDENCE

BIT OF HISTORY

IN the issue of SCIENCE for August 15, 1913, there is quoted from *The Independent* of fifty years ago the statement that "Professor Wolcott Gibbs" had been chosen to the Rumford

chair at Harvard College together with the well-worn comment of

Columbia College a year or two since refused to appoint him to a chemical professorship. Because he did not understand chemistry? No; because he was a Unitarian!

At the time of the death of Professor Gibbs this statement also appeared in several of the "official" sketches that were published. As the story differed somewhat from the one that prevailed at Columbia when I was an undergraduate, I undertook to ascertain the facts for my own satisfaction and have arrived at the following conclusions:

In 1854 Wolcott Gibbs (easily the most distinguished of the many eminent scientists who have graduated from Columbia) was filling the chair of physics and chemistry in the College of the City of New York. He had only recently returned from Europe, where he had studied in Germany under Liebig and in France under Regnault, but had not as yet given any distinct evidence of his brilliant powers as an investigator, nor had he published papers that indicated his great genius.

It was also in that year that a successor was sought at Columbia for the illustrious James Renwick, who since 1820 had added to the prestige of his alma mater by serving her as professor of chemistry.

Various candidates were proposed and among them naturally enough the young alumnus of Columbia, who was then filling acceptably a teaching professorship in the Free Academy, as the City College was then commonly called. The trustees, however, in their wisdom chose Richard McCulloh, a man of more mature years than Gibbs and one who had already given promise of the future by his valuable work on the United States Coast Survey, then the foremost scientific bureau of the national government. That he filled the place satisfactorily is shown by the fact that three years later he was transferred to the chair of mechanics and physics, which he then held until October, 1863, when, as the General Catalogue has it, he "abandoned his post and joined the rebels."

Admirers of Professor Gibbs, however, have ever since persistently contended that Gibbs was rejected because he was a Unitarian, and even an appeal was presented to the New York state legislature[1] in which it was claimed that his rejection was made for sectarian reasons.

That Columbia has always had leanings toward the Protestant Episcopal faith is perhaps most significantly shown by the facts that the Bishop of New York and the rector of Trinity Church are ex-officio members of the board of trustees. But it must be remembered so also is the senior minister of the Dutch Reformed Church; and also again it must be remembered, that no evidence has ever been presented as to the faith of Professor McCulloh.

Much as I regret the decision of the trustees in depriving Columbia of the services of him, who, in the paths of science proved himself to be her most eminent alumnus, and also who ever inspired those who were so fortunate as to study under him with a true love of science, nevertheless, in these modern days, when church unity is the hope of so many, is it not time to cease the persistent criticism of Columbia for her sectarianism and to accept the more reasonable conclusion, entirely consistent with the facts, that McCulloh was chosen to the faculty because the trustees believed him to be the better man and not because Gibbs was a Unitarian.

MARCUS BENJAMIN

THE LAW OF PRIORITY

ON general principles it can not be denied

[1] Professor J. H. Van Amringe, Columbia's most beloved alumnus, in a recent letter, calls my attention to the fact that in response to this appeal a committee of the New York Senate was appointed to ascertain whether the trustees had required any "religious qualifications or test from any candidate as a condition of any professorship in said college." As a result of the inquiries the committee "arrived at the clear and decided conviction that there had been no such violation." See "A History of Columbia University. 1754–1904," New York, 1904, page 129.

that we must have uniform and consistent law, as has been stated by a recent contributor to the discussion, if we desire a stable system of nomenclature; in fact it goes without saying that this is quite essential.

But sundry knotty problems arise. For example when we observe in a recent catalogue that the word *Sunius*, for a well-known genus of beetles, which we have known hitherto only by that name, which our fathers and grandfathers knew only by that name, which in fact is the only name by which the genus has been known in virtually the entire domain of literature, must be changed and replaced by *Astenus*, we pause to ask why. It may be admitted that some one connected with the catalogue has gone back and at least thought he understood that the original diagnosis—these old descriptions being almost meaningless nine times out of ten—of *Astenus*, applied better to what we have known as *Sunius* than to anything else; but we are given no visible evidence whatever. Are we blindly to change the lifelong conception of several generations and reverse all published literature of the genus, on the authority of a guess and without presentation of any sort of proof? The language of the original description must alone afford this proof, for there is no way of knowing that the original type label may not have been shifted in some way, if the type chance to be in existence.

The pity of the interminable tangle may be reduced to this: If these over-zealous advocates of strict priority had only refrained from such publication until some system could be formulated, it would have been possible to adopt a uniform and consistent law which need not be necessarily that of rigid priority. One that might, for example, be analogous to the legal rule of exemption after a certain time limit. That is: If a genus name has not been challenged or corrected during a continuous period of say sixty or seventy years after its introduction in the commonly accepted sense, then it is to be considered permanent. This is absolute and consistent law and nothing else.

But the enthusiastic explorers of antiquity have spoiled this otherwise available recourse and I am free to confess that, as matters now stand, there seems to be no rational way out of the trouble but definitely to adopt the law of absolute priority. I would, however, only accept the identifications made by a competent commission, which should be compelled to publish its results in the fullest and broadest possible manner and in such a convincing way, by adducing the necessary proofs, that there could be no just ground for dissent. I feel that the enthusiasts aforesaid have compelled this course, because if we now use the old genus name *Ips*, for example, without further qualification, one would not know whether we refer to a Nitidulid or a Rhynchophorid beetle (*Tomicus* Latr.), to give only one instance among many.

So the very chaos which has come about through premature efforts to adhere to the law of strict priority now forces the adoption of that law, but only in the rigid way suggested above. In other words, incontrovertible evidence must be clearly and widely published, proving that the change is necessary. This opens up another vexing field of dispute. The subject is really serious and should be given the attention of the ablest natural historians now and without further delay, so that a secure foundation may be laid for future generations. Other work should be laid aside until this foundation is secure.

THOS. L. CASEY

WASHINGTON, D. C.

SCIENTIFIC BOOKS

Geometrical Optics. By ARCHIBALD STANLEY PERCIVAL. London, Longmans, Green, and Company. 1913. Pp. vi + 132.

This volume, issued recently, is intended for medical students as a text-book introducing them to so much of optical theory as may be necessary for the ophthalmic surgeon. The mathematics of the subject is hence free from applications of calculus, but the algebra involved is enough to cause most American

medical students to quail. The author assumes thorough knowledge of algebra, geometry and trigonometry, including particularly the vectorial significance of linear direction.

Physical optics is avoided entirely, since "no thorough elementary knowledge of that intricate subject can be obtained in the short time allotted to the student for studying optics." It is questionable whether this truth warrants the pedagogic loss involved in ignoring the wave theory of light. Elementary knowledge may be correct so far as it goes, but without involving intricacies. Children are taught in the grammar-school some of the conclusions resulting from the Newtonian theory of gravitation, but without any reference to the difficulties overcome in its establishment. The wave theory of light is now about as well established as the theory of gravitation. To assume it at the outset of a course in elementary optics is common enough to-day. For the college student this assumption is probably accompanied quite generally with the promise that he who perseveres will in time be provided with adequate foundation for the faith which is accepted without question at the outset. In deducing and applying the elementary formulas of optics the use of wave fronts is found to simplify demonstrations that are equally possible without them. Wave fronts and rays are quite inseparable instead of being mutually exclusive. The judicious teacher will be apt to guide himself by convenience and economy in reaching a decision as to a choice of methods of demonstration.

In text-books on optics there is unfortunately no definite consensus thus far in regard to the conventional assumptions to be applied in the development of theory. From the standpoint of the teacher and the manufacturer certain conventions may be useful which are unsatisfactory to the advanced student of theory. In every case they should be as simple as possible, so as to be really helpful. For the elementary student, and even the advanced student, probably the most troublesome snare is the minus sign. Mr. Percival says (p. 22): "We have adopted the usual conventions that directions from left to right are considered positive, and those from right to left negative." Similarly, upward is positive; downward, negative; counter-clockwise angular rotation is positive, clockwise, negative. This seems like simplicity itself; but in its application the elementary student of optics finds himself soon confused. In many cases mere magnitude is all that needs consideration, and to introduce additionally the element of direction, especially rotational direction, merely increases the chances of misinterpretation. For example, the deviation, D, which a prism of refracting angle A imposes on a beam of homogeneous light sent through it is commonly expressed in terms of A and the angles of incidence, ϕ, and emergence ψ, by the formula,

$$D=\phi+\psi-A.$$

Mr. Percival expresses this in words by saying (p. 43): "The total deviation is equal to the difference between the angles of emergence and incidence less the apical angle of the prism." A glance at the diagram is enough to satisfy any student of geometry that the former expression is correct. The author requests the reader to note that ϕ is measured clockwise and ψ counter-clockwise; but the introduction of this convention is here wholly unnecessary and misleading.

The formula for a thin lens in air is one of the most important in optics. Let us assume, as standard form, a bi-convex lens, with refractive index, n, radius of curvature r_1 on the side of incidence, and r_2 on that of emergence. Let this lens receive light from a radiant at distance u, and converge it to a conjugate focus at distance v. The relation existing is expressed by the equation,

$$\frac{1}{u}+\frac{1}{v}=(n-1)\left(\frac{1}{r_1}+\frac{1}{r_2}\right). \qquad (1)$$

The conventional assumptions involved are:

1. Irrespective of direction, the radius of curvature is positive for a convex lens surface, and negative for a concave lens surface.

2. Irrespective of direction, the curvature

is considered positive for a wave front propagated toward or from a real focus; and negative if from a virtual focus.

Another form commonly seen is,

$$\frac{1}{u}-\frac{1}{v}=(n-1)\left(\frac{1}{r_2}-\frac{1}{r_1}\right). \qquad (2)$$

The assumptions now involved are:

1. The direction from lens toward radiant is positive; its opposite is negative.

2. Curvature concave toward the radiant is positive; its opposite is negative.

If it is assumed additionally that the radiant is at the right of the lens, Mr. Percival's convention is expressed in Eq. (2).

The conventions connected with Eq. (1) have long been in common use. A converging lens is commonly called positive; a diverging lens, negative. Of late years Eq. (2) has been increasingly coming into use, for analytical reasons. The teacher of optics is free to take his choice; and this is apt to be influenced, in part at least, by ease of application. In a text-book published about twenty-five years ago by a pair of highly respected American college teachers of physics the deduction and discussion of Eq. (2) is given; but at its close they add the remark: "The equation is more simple in application if, instead of making the algebraic signs of the quantities depend on the direction of measurement they are made to depend on the form of the surfaces and the character of the foci." The conventions given in connection with Eq. (1) are then expressed. The present writer has tried both sets of conventions with his students; and with the result that pedagogically Eq. (1) is found much preferable. On examining thirty text-books in his library he finds Eq. (1) used in sixteen of them; Eq. (2) in thirteen; and both in one of them.

Mr. Percival seems to select the position of the radiant as origin, for in his diagrams he places this at the left, or negative, side of the lens or mirror; but this is not always done by him. He makes a distinction (p. 49) between the convention applied in *finding* a general formula and that applied in *using* a formula, saying, "when using the formulæ it will generally be found convenient to regard the direction of the incident light as the positive direction." The ordinary student, expecting uniformity and consistency, will be apt to stumble here, especially if he consults Edser's excellent book "Light for Students," and finds (p. 28), that "when the direction of measurement is opposite to that in which the incident light travels, the distance is positive." In this connection it should be noted that both Edser and Percival use the same form, expressed in Eq. (2). The positive direction for this equation may thus be either rightward, or leftward, or in the direction of propagation, or opposite to this direction, according to preference. The student probably has no preference, but wants definite information. After reversing his minus sign, and then re-reversing it a sufficient number of times, his mental condition becomes undesirable, to say the least.

Taking the equations as they are found in Mr. Percival's volume, he illustrates them by the solution of numerical problems, and in a number of cases additionally by graphic methods. The discussion of Gauss's cardinal points for a thick lens, or system of lenses, is perhaps scarcely full enough to enable the student to acquire very satisfactory working knowledge of the subject. Its application to the optics of the human eye is well illustrated both numerically and graphically.

An appendix is added in which a number of topics of practical importance are treated mathematically, without any attempt to avoid or disguise the notation of calculus. Medical students, for the most part, may naturally be disposed to accept the results without mastering the details of demonstration.

There are a few obvious typographical errors that will probably be corrected in a future edition. Despite the uncertainties about linear and angular direction, the book is clearly written, and by one who has evidently had good experience in dealing with students. It is worthy of commendation to those for whom it was intended.

W. LECONTE STEVENS

LEXINGTON, VA.,
September 2, 1913

Prevention and Control of Disease. By FRANCIS RAMALEY and CLAY E. GRIFFIN. Copyright by Francis Ramaley, Boulder, Colorado. 1913.

In the preface to the book the authors state the purpose for which it has been written. The work of investigators, physicians and public health officers should be more widely known in order that an intelligent body of citizens may cooperate in its extension. The book is intended for the general public and as a text for college classes. It is not written for medical students or biologists. After discussion of death rate, types of disease and certain hygienic considerations nine chapters, constituting almost half of the book, are given to a concise summary of the "germ theory of disease," the nature, life-history, metabolic activity and distribution of animal and vegetable parasites, the mode of infection and spread of infectious diseases, disinfection, susceptibility and resistance, immunity and specifics in the treatment of disease. One familiar with the complexity of any biological science may doubt the possibility of conveying to the general reader a conception of the nature of the objects or of the phenomena described or in the absence of a clear understanding of the subject the possibility of maintaining his interest. For those who wish this information a satisfactory synopsis is furnished. It is even more doubtful if matter described in this part of the book can be used as the basis of a collegiate course. To appreciate the form and life-history of bacteria and protozoa and the chemical changes caused by them both preliminary biological training and objective demonstration of selected forms may be regarded as essential. Study of the phenomena of immunity including the intricacies of Ehrlich's side-chain theory or of phagocytosis and opsonic action must be relegated to the biological student who wishes to acquire technical training and superficial information may leave the impression of occult mystery in the mind of the general reader. The book contains a large amount of information which the layman should have and it is presented in interesting form. The statements concerning medical practise are generally accurate, but occasionally an indefinite or erroneous impression is produced. Advice to eat moderately at the beginning of a "cold" may be worth heeding, but its value is not strengthened by the suggestion that side-chain receptors become coupled to toxins when intoxication takes place and the body is unable to assimilate food until new side chains are developed. The cause, dissemination and prevention by personal and governmental precautions of "cold," diphtheria, contagious diseases of childhood, tuberculosis and other diseases are adequately discussed. The value of vaccination and of the serum treatment of diphtheria is emphasized with the purpose of overcoming lingering prejudice. As an illustration of desirable information which may aid the layman to judge his professional attendant may be cited the author's discussion of the importance of surgical cleanliness on the part of dentists. Historical data defining the changes that have occurred in the prevalence of certain diseases or describing the progress of medical discovery add interest and clearness to the book.

E. L. OPIE

SPECIAL ARTICLES

ON INDUCING DEVELOPMENT IN THE SEA-URCHIN (ARBACIA PUNCTULATA), TOGETHER WITH CONSIDERATIONS ON THE INITIATORY EFFECT OF FERTILIZATION[1]

I. THE INITIATION OF DEVELOPMENT WITH DILUTE SEA WATER

IN the course of work on the energetics of development, it became necessary to study in detail the question of water absorption at various stages of embryogeny. For certain phases of these studies the eggs of *Arbacia punctulata* proved extremely favorable. In various concentrations of sea water these eggs behave exactly as expected, but in 25 per cent. sea water (25 c.c. sea water + 75 c.c. H_2O dist.) fertilization membranes appear. The process takes place in from one to one and a half minutes at ordinary temperatures. In two minutes many eggs as well as their nuclei

[1] Preliminary communication.

are cytolized, and in three minutes this is true of most of the eggs.

The membrane in question is a true fertilization membrane, and if at the proper moment the eggs are brought back into normal sea water, or better still, hypertonic sea water (50 c.c. sea water + 8 c.c. 2.5 N NaCl), cleavage takes place. Since July 18 I have succeeded in rearing a considerable number of ciliated larvæ.

II. THE INITIATION OF DEVELOPMENT WITH EGG EXTRACT

If fresh ovaries of *Arbacia* are ground up in a mortar with pulverized glass and a small quantity of sea water, the liquid, when filtered, has a color not unlike that of blood serum. This fluid, if allowed to act on ripe eggs contained in an equal quantity of sea water, proves to be an excellent initiatory agent, for if the eggs after one to two hours are placed in normal sea water, many divide, although no fertilization membrane appears.

III. THE THEORY OF INITIATION, PARTHENOGENETIC METHODS AND THE FERTILIZATION MEMBRANE

It is well known that development can be induced in many kinds of eggs by very diverse means—lipoid solvents, increased osmotic pressure of the surrounding medium, electricity, heat, cold, mechanical shock and even pricking the egg surface, have all proved effective in one case or another, but so far as I am aware the use of egg extract from the same species is new, as well as the production of genuine fertilization membranes in *Arbacia punctulata* by means of dilute sea water. In one of the California sea urchins, Loeb[3] has reported the formation of membranes after the addition of distilled water, but from certain details it seems that the fertilization membrane of at least one of the California urchins resembles that of *Asterias forbesii*, and this differs quite markedly from that of *Arbacia punctulata.*

Loeb,[3] on the basis of his own investigations and those of others, has formulated a theory on the initiation of development which for normal fertilization and certain of the parthenogenetic methods, postulates (*a*) an increased permeability of the ovum due to the action of lipoid solvents or hæmolytic agents; (*b*) the formation of a fertilization membrane in consequence of this superficial cytolysis.

Of an increase in permeability synchronous with the initiation of development there is not the slightest doubt, although the great variety of parthenogenetic methods long ago indicated that permeability is increased, in other ways than by action on surface lipoids. With the employment of some parthenogenetic methods, fertilization membranes appear, with others, not, and even the employment of lipoid solvents themselves may or may not be followed by the appearance of a fertilization membrane. One and the same egg, as in the present case, may be induced to develop with or without the appearance of such a membrane.

IV. EXPERIMENTAL ANALYSIS OF THE FERTILIZATION MEMBRANE

According to Kite's[4] dissection, the egg of *Arbacia* has a vitelline membrane tightly glued to its surface. Outside this is a thin jelly. The appearance of the fertilization membrane, according to this description, is due to the swelling of the vitelline membrane, and the formation of a phase boundary between it and the thin outer jelly.

This description I believe to be essentially correct for the following reasons:

1. The fertilization membrane also has an inner visible boundary. In certain localities of the two- and four-cell stage this inner surface of the fertilization membrane is plainly visible, has indeed been often figured and I believe misinterpreted. In the stages in question a narrow perivitelline space can be seen around the egg, but the fertilization membrane adheres to the egg surface here and there by strands. As a consequence, when

[3] Loeb, Jacques, "Die chemische Entwicklungserregung, etc.," Julius Springer, Berlin, 1909.

[4] Kite, G. L., "The Nature of the Fertilization Membrane, etc.," SCIENCE, Vol. XXXVI.

the egg divides, some of these strands are drawn down between the cleavage cells, and as certain portions of the surface of these are further removed from the fertilization membrane than the original egg, the inner limit of this membrane, as well as the perivitelline space itself, becomes visible. The perivitelline space seems to be identical with the so-called "hyaline plasma-layer," and homologous with the perivitelline space of the fertilized starfish egg.

2. By means of hypertonic solutions as well as by extract of themselves, sea-urchin eggs can be induced to divide without the appearance of a fertilization membrane. Development, however, does not proceed normally because the blastomeres fall apart. Since the vitelline membrane is tightly glued to the surface of this egg and a perivitelline space appears after the membrane has swollen, eggs dividing without the formation of this space have the membrane adhering to the resulting blastomeres. In consequence, these cells, instead of being in intimate contact with one another as they normally are, are each enclosed in a separate vitelline membrane. In other words, when the vitelline membrane is not lifted off the egg surface, it divides with the egg, which is what one would expect. If this idea is correct, cleavage cells which have originated by the division of an egg without a "fertilization" membrane should be able to "form" such membranes under suitable conditions, and this I have observed. Immersed in dilute sea water, isolated cleavage cells, derived from ova which have not formed "fertilization" membranes, form them in from one to two minutes.

3. Egg fragments can also be produced by shaking. No fertilization membranes appear in such eggs or their fragments as the result of the mechanical agitation, but when treated with dilute sea water or sperm, membranes appear in some of the fragments, but not in others. Both kinds of fragments have been fertilized with sperm and allowed to develop, some with and some without the membrane. This result can only be understood if we accept Kite's discovery that the fertilization membrane in *Arbacia punctulata* appears when a preexisting jelly, closely adherent to the surface of the egg, swells and changes its optical properties.

4. From the above experiments one may infer that a fertilization membrane may appear around part of an egg, instead of the whole. If Kite's jelly is ruptured the egg flows partially through the hole in the membrane, and assumes a dumbbell shape. If it is now fertilized with sperm, or treated with dilute sea water, a fertilization membrane appears on one sphere of the dumbbell, but not on the other. Such eggs are capable of development.

5. The appearance of a fertilization membrane in *Arbacia punctulata* is not a function of the living egg, for if the egg is crushed, or even dried completely in a desiccator for days, membranes still appear after proper treatment.

V. WHAT MAKES THE FERTILIZATION MEMBRANE APPEAR NORMALLY?

If the interpretation given to the results outlined is correct for *Arbacia punctulata,* it is easy to see why the fertilization membrane should appear in dilute sea water, or in distilled water. But why does it appear under normal conditions in sea water?

The exact mechanism of the process is not yet clear, but it seems to be a function of the number of sperm present. If one inseminates eggs very carefully so that not more than four or five spermatozoa come into contact with each one, the fertilization membrane does not appear. I have repeated this experiment many times and have controlled it by the most careful observations with different powers on fresh material as well as stained. Such preparations show sperm plainly adhering to Kite's jelly in every egg, but the "membrane" does not appear. Eggs treated in this manner do not develop, although some of the smaller ones may form asters. What it is in the sperm that brings about the swelling of the jelly has not yet been determined. However, beautiful fertilization membranes may be caused to appear in two to three hours by treating the eggs with minute infusoria.

No membranes appear in the controls, nor do the eggs whose membranes have appeared develop when returned to sea water. Three possibilities suggest themselves—an acid effect, a mechanical effect or a heat effect. No decisive experiment has as yet been devised.

These experiments suggest that in *Arbacia punctulata* the membrane swells before the sperm enters the egg, and not after. Experiments also show that when the phase boundary between Kite's jelly and the outer jelly is complete, sperm do not readily penetrate the fertilization membrane. From this it follows that the penetration occurs at the moment when the jelly is softened and begins to swell. Accordingly, eggs whose jelly has been partially softened by heat or infusoria should be capable of fertilization with small doses of sperm. This has actually been observed in a number of instances. The opposite experiment of hardening the jelly with Ca has been performed. Such eggs are extremely difficult and in many cases impossible to fertilize as the sperm do not stick.

VI. THE RELATION BETWEEN FERTILIZATION AND THE FERTILIZATION MEMBRANE

The relation between the initiation of development and the fertilization membrane in *Arbacia punctulata* is one of association rather than "causal," for the membrane may be made to appear without development, and development may be initiated without the appearance of the membrane. In *Asterias forbesii* the association is somewhat different, and so intimate that any method which causes the membrane to appear is at the same time a method of initiation provided the violence is not too great and the egg is in good condition and in a suitable medium. The explanation is simple. In *Asterias* the fertilization membrane does not depend on the swelling of a formed jelly, but instead, the egg peels itself away from the inner surface of a thin preexisting membrane. This peeling away seems to depend, not upon changes in the fertilization membrane, but upon changes in the surface film of the egg. When this is rendered more permeable, material leaves the egg and the egg shrinks away from its closely adherent covering which thus becomes visible. The perivitelline space in the starfish egg is homologous with that of the sea urchin egg, but is much larger.

The type of fertilization membrane found in *Arbacia punctulata* may be called hydrophilous, that of the starfish, *Asterias forbesii*, anhydrophilous.

VII. ON THE LOSS OF SUBSTANCES BY THE EGG AND THEIR NATURE

The starfish egg upon peeling off from its anhydrophilous fertilization membrane is markedly smaller in volume than before. The same thing is true of *Arbacia*. Exact measurements will be given when I publish exact details of these experiments. No doubt much of the material lost by the egg is water. F. R. Lillie[4] in a series of fundamental researches has shown that the fluid over-fertilized eggs may contain at the least two classes of substances, (*a*) "iso-agglutinins" and (*b*) a substance having a chemotactic influence on the sperm. From Elder's[5] investigations as well as certain observations of my own, it appears possible that the chemotactic substance is contained in the outer jelly of the *Arbacia* egg. I have been able to verify the "iso-agglutinin" and its effects as described by Lillie in the case of *Arbacia* and *Asterias*.

Ovarian extract of *Arbacia*, when present in sufficient quantities, retards the development of normally fertilized *Arbacia* eggs. If the extract is added to blastulæ which have developed in normal sea water, these are instantly slowed down and absorb water. *Arenicola* larvæ also have their permeability increased by the *Arbacia* extract, as can be very prettily seen by their loss of pigment. They also slow down in their movements and are slightly and reversibly agglutinated.

[4] Lillie, F. R., "Studies of Fertilization," I. and II., *Jour. of Morph.*, Vol. 22; III. and IV., *Jour. of Exp. Zool.*, Vol. 12; V., *Jour. of Exp. Zool.*, Vol. 14.

[5] Elder, J. C., "The Relation of the Zona Pellucida to the Formation of the Fertilization Membrane," *Arch. f. Entwicklungsmechanik*, Vol. 36.

These observations suggest that the ovarian extract, as well as the secretions of the egg on fertilization contain substances that not only influence permeability, but may reduce the oxidations in the cell.

VIII. THE THEORY OF INITIATION

The theory of initiation, as given by Loeb, postulates essentially that initiatory influences place the egg in a condition in which its oxidative processes can proceed, or proceed normally. This is accomplished by increasing the permeability of the egg, and in the case of many parthenogenetic agents, as well as in normal fertilization by sperm, the permeability change may be brought about by lipoid solvents. The fertilization membrane may or may not appear after the use of lipoid solvents, and when, as in the case of the starfish egg, it does appear, it may also be made to do so with any other method of increasing the permeability of the plasma film. These facts, many of which have been emphasized by Loeb,[5] R. S. Lillie[6] and others, by no means prove that the theory of initiation is wrong. Indeed, they are all in harmony with this view if we remember that an hydrophilous fertilization membrane may or may not appear, depending on circumstances, whereas an anhydrophilous one like that of *Asterias* is certain to appear when, as the result of a permeability change, the egg shrinks away from its enclosing capsule.

How can increased permeability initiate development?

The ovum demonstrably has the necessary mechanism to undergo development of itself. It is a cell with a long metabolic history and before development is initiated its plasma film is relatively impermeable. This may involve the accumulation of "waste" products, and these we may believe to automatically inhibit further metabolic processes. Loeb has shown that these processes are oxidations, and my experiments show that substances can be extracted from the eggs which reduce the rate of development and have a marked effect in decreasing the activity of *Arbacia* as well as *Arenicola* larvæ. It does not seem unreasonable to suppose therefore that these materials are active because they reduce oxidations. The mere fact that they also increase cell permeability and are good initiatory agents is beside the point, for increased permeability in *Arenicola* larvæ is also associated with acceleration of movement.

[6] Lillie, R. S., "The Physiology of Cell Division," *Jour. of Morph.*, Vol. 22.

One may extend the theory of initiation and assume that all agencies that initiate development do so because through increased permeability of the plasma film the egg is enabled to loose substances antagonistic to oxidation. By freeing itself of these inhibitors, a chemical equilibrium is disturbed, and oxidation, and with it development, is free to go on.

In this way we can explain why a mature starfish egg, if unfertilized, may oxidize itself to death, for we may suppose that its permeability has been sufficiently increased by maturation to accelerate oxidation, but not enough to initiate development proper. We can also bring all parthenogenetic methods whatsoever, as well as normal fertilization, under a common point of view, for the increased permeability, no matter whether produced by electricity, heat, cold, mechanical shock, specific chemical alteration of the membrane, lipoid solvents, or pricking, is all that is necessary to enable the egg to free itself from its accumulated inhibitors. Why the egg should develop after treatment with hypertonic solutions is also clear, for if in such media the plasma film is permeable to the inhibitors, loss of water by the egg would, directly or indirectly, accelerate the loss of antagonists. That these are lost in hypertonic sea water is shown by special experiments.

In conclusion, I must thank my colleague, Dr. W. E. Garrey, who kindly allowed me to demonstrate to him various steps in the investigation, and to whom I am indebted for a number of valuable suggestions and criticisms.

OTTO GLASER

WOODS HOLE, MASS.,
August 4, 1913

THE SOCIETY OF AMERICAN BACTERIOLOGISTS. III

PATHOLOGIC BACTERIOLOGY

Cultivation and Differentiation of Fusiform Bacilli: CHARLES KRUMWIEDE, JR., and JOSEPHINE PRATT, Research Laboratory, Department of Health, New York City.

Isolation: Dilutions of the original material are made in a series of tubes of ascitic fluid or horse serum. To these is added fluid agar and they are then poured in the covers of petri dishes. While the agar is still fluid the lower part of the petri dish is laid on the agar, giving a layer of agar between the two parts of the dish. After forty-eight to seventy-two hours the upper glass is separated from the agar and the distinctive colonies fished. The colony is characterized by the thread-like outgrowths from one or both sides of the colony. Cultivation: A semi-solid medium employing stab inoculation is most convenient for preservation of cultures. The puncture closes after inoculation and subinoculations are easily performed, due to the softness of the medium. Aerobic contamination is quickly noted. The medium is prepared as follows:

Agar	10 gms.	2 parts
Gelatin	80 gms.	
Veal broth, 2 per cent. peptone, no salt	1,000 c.c.	
Horse serum or ascitic fluid		1 part

Horse serum has given more uniform results than ascitic fluid. Although there is a difference in various strains in their ability to grow on simple media, serum containing media are necessary for surety of cultivation of all strains.

Source and Number of Cultures being Studied

Noma	2 strains	Total 15
Vincent's angina	5 strains	
Spongy bleeding gums	1 strain	
Pyrrhœa	2 strains	
Chronic otitic media foul discharge	3 strains	
Carious teeth	1 strain	
Ulceration of tongue	1 strain	

Morphology and Cultural Differentiation: The typical bacillus is more or less pointed. In cultures they are extremely pleomorphic, filaments and wavy forms simulating spirochetes being found. No morphological differentiation has been made. Sugar fermentations show some differences, but these differences show no relation to the source of the culture. Pathogenicity: Abscesses can be produced under the thin skin covering the cartilage of the ear of rabbits. Relation to Spirochetes: Spirochetal-like forms can be found especially in fluid media. The relation of these to the spirochetes in the original material has not been sufficiently studied.

The Morphology of Cultural Amebas: ANNA WESSELS WILLIAMS, Research Laboratory, Health Department, City of New York.

The paper was a report of the studies on cultural amebas grown under conditions as nearly as possible like those of the habitat from which the amebas were obtained. "Ameba 11,524," obtained originally by Musgrave and Clegg from the stools of a case of human amebic dysentery, when grown on fresh brain tissue medium at high temperature (34° C. to 38° C.) for several days with the addition each day of fresh blood and, after two days, of small amounts of certain bacteria, continues a vigorous growth and shows from day to day a marked pleomorphism. The organisms lose their contractile vacuole and the nuclei assume many of the appearances described as characteristics of the "entameba" group in man. As many as eight nuclei have been found in a trophozoite, and six in a cyst, the usual number so far seen is four in each. In this particular as well as in size and in a "cyclic" change of the karyosome, this species most frequently resembles the pathogenic species described as *Entameba tetragena.* Conclusion: (1) Cultural amebas isolated from the stools of dysenteric patients, are much more complicated in morphology than we have been led to think, and grown under conditions approaching those found in the intestines they closely resemble species described as strict parasites. (2) The question of species and pathogenicity of amebas found in dysenteric stools will probably be settled finally and not until then, when a comparative study is made of amebas in their natural habitat with pure cultures isolated from the same cases and grown *under conditions similar to those found in the habitat from which many were isolated.*

Observation on the Intestinal Bacteria in Pellagra: W. J. MACNEAL.

This report is based upon the work of the Illinois State Pellagra Commission[1] and of the Thompson-McFadden Pellagra Commission of the New York Postgraduate Medical School. A general survey of the fecal bacteria by the methods previously employed in studying the feces of healthy men[2] showed considerable variation from

[1] *Archives of Internal Med.*, August, 1912, pp. 123–168, and September, 1912, pp. 219–249.

[2] *Journ. of Infec. Diseases*, Vol. 6, No. 2, April, 1909, pp. 123–169, and Vol. 6, No. 5, November, 1909, pp. 571–609.

the normal numerical relationships and the advent of new types of bacteria, not observed in healthy men. The most evident change was the relative increase in certain normal types such as *B. bifidus*, *B. welchii* and the micrococci. The cocci were always increased during the acute attack. Other changes were not constant. About 800 bacterial strains were isolated by plate cultures of feces and of intestinal juice obtained through the Einhorn duodenal tube, and these were subjected to agglutination tests with serum from pellagrins at Peoria, Kankakee and Chicago, Ill., and Spartanburg, S. C. One of the bacterial strains is completely agglutinated by the serum of 81 of 109 cases of pellagra (74.3 per cent.), and by 11 of 45 control cases believed to be free from the disease. Similar organisms have been found in the duodenal juice in a few others. The work is being continued.

A Study of Diarrhea in Infants: A. W. Street, Brown University.

This work is a study of the rapid diagnosis of dysentery from the stools of infected infants. It consists of inoculation in special broth tubes from the swabs of the stools, and subsequent isolation of the organism believed to be the cause of diarrhea. We used litmus-lactose-agar and Endo plates and transferred the characteristic growth to other tubes to show cultural characters. In our work we found Russel's medium particularly good for differentiation of the group, and litmus-milk good for differentiation of the two main types. We also used lactose-peptone bile, saccharose and dextrose broth, gelatine, peptone and mannite-litmus semi-solid medium. The incubations were all at 37° C. except gelatine, which was at 20° C., but for varying lengths of time. Generally the incubations were for eighteen hours. Not all the cases were sent to be diagnosed—only the most severe and those reported to the nurses by the physicians. The agglutination test, which is recognized as the most conclusive, was not regularly tried, because of the fact that no good serum was immediately procurable. Agglutination occurs, however, in dilutions of 1:200 and 1: 500. Of the cases sent in, which numbered 47, seven showed reactions of those of the dysentery group. They produced acid in litmus milk, and so are of the Flexner type. Many showed reactions in culture tubes very similar to the control tubes, but these failed to check up in one tube or another. So that we are able to conclude that the method of rapid isolation is practical, as is shown in seven of forty-seven cases, or 14.89 per cent.

Bacteriology and Control of Acute Infections in Laboratory Animals: N. S. Ferry, Detroit, Michigan.

Diseases in Epidemic Form Studied: An infection in rabbits, dogs, guinea-pigs and monkeys due to the *B. bronchisepticus*, the microorganism which has been found to be the cause of canine distemper and an infection among rabbits due to the bacillus of rabbit septicemia. Study of Organisms Resembling the *B. bronchisepticus:* During the course of the studies on the epidemic which raged among the several animals ten different organisms were encountered which resembled the *B. bronchisepticus* somewhat in their morphology, their early growth on agar and their behavior toward Gram's stain. A careful study of these organisms showed them to be connected with the epidemic only in the capacity of secondary invaders. Primary Infection: The primary infection was found to be due to the *B. bronchisepticus.* Agglutination tests showed the *B. bronchisepticus* to be absolutely distinct from any of these other organisms. Control of Epidemics: The epidemics were controlled by isolation, antisepsis and the use of prophylactic injection of vaccines made from the specific microorganisms. Epidemic due to the Bacillus of Rabbit Septicemia: After the epidemic due to the *B. bronchisepticus* was under control, an epidemic broke out among the rabbits, due to the bacillus of rabbit septicemia. This epidemic proved very fatal before it could be controlled. The same methods of control were carried out as before. Value of the Protective Inoculation: Although all animals can not be saved by means of the prophylactic injection, control experiments have proved that a large majority are protected.

The Lesions produced by Intra-bronchial Insufflation of B. prodigiosus: Martha Wollstein, M.D., and S. J. Meltzer, M.D.

We inoculated broth cultures of *B. prodigiosus* into the lungs by means of intra-bronchial insufflation, which consists of the introduction of a tube through the mouth, larynx and trachea into a bronchus, and the injection of the fluid culture through the tube. Doses of 5 c.c. to 15 c.c. of a twenty-four-hour broth culture injected into the lungs of dogs were uniformly fatal in six hours to three days, the great majority of animals dying within twenty-four hours. It was not until the dose was reduced to one cubic centimeter that three out of five dogs survived until the fourth day. The entrance of *B. prodigiosus* into the blood stream followed intra-bronchial insufflation

of all doses of one cubic centimeter or more of this organism. The bacillus grew profusely from the heart's blood of every case examined, from five and three fourths hours to four days after inoculation. After the fourth day no growth could be obtained from either heart or lungs. The pulmonary lesions produced by intra-bronchial insufflation of *B. prodigiosus* in dogs differed very markedly from the experimental pneumonias which have hitherto been produced by other bacteria administered in this way. Thus large doses (5 to 15 c.c.) caused pulmonary lesions which were chiefly hemorrhagic and necrotic in character, with a large production of fibrin. Bacteremia and death were the rule. The lung lesions were more severe and the death rate higher than was the case with other bacteria administered intra-bronchially. Very small doses (0.5 c.c.) caused a fibrinous inflammation, lobular at first, later coalesced and lobar in distribution, without evidence of necrosis. No bacteremia followed these small doses and recovery was possible.

Frequency of Vincent's Angina among Routine Throat Cultures: John L. Rice, Syracuse Medical School.

From the examination of 1,352 routine throat swabs 10, or seven tenths of one per cent., were found to be both bacteriologically and clinically Vincent's angina, both the fusiform bacillus and the spirochete being found. Four of the ten cases were clinical cases of diphtheria, showing that 40 per cent. of the Vincent's angina cases were also positive for diphtheria. In twelve other cases of the 1,352 the bacilli or the spirochetes were found alone. None of these twelve cases were clinically Vincent's angina. Morphologically the bacilli in the clinical and non-clinical cases were alike. In a microscopical examination of a smear from the swabs a diagnosis can be made by finding fusiform bacilli and spirochetes in symbiosis, even though the number of spirochetes present may be small.

Studies on the Etiology of Hog Cholera: Walter E. King and F. W. Baeslack, Research Laboratory, Parke, Davis & Co., Detroit, Mich.

This report is presented for the purpose of recording certain observations, which have been made by the aid of the dark field on the blood of hogs suffering from hog cholera. During the last few months a spirochete has been found with uniformity and constancy in the blood of every cholera hog examined. Practically all of these positive findings have been controlled by one or more careful dark field examinations of the blood before inoculation. Additional checks are furnished in several cases by negative findings subsequent to positive results in blood of hogs recovered from the disease. In so far as the present results go, the practised observer can readily distinguish certain characters in the blood of animals suffering from hog cholera when placed on the dark field, as differentiated from normal hog blood. Hog cholera blood usually contains many granules, some very fine yet distinctly larger than blood dust, some larger still, and some very distinct, highly refractive bodies. It is possible that some or all of these granules represent disintegrated blood elements resulting from the disease. It is suggested, however, that some of these granules may represent certain stages in the life cycle of the spirochete under observation. To date, positive findings of this spirochete are recorded in 10 strains of virus from the blood of 33 hogs suffering from the disease. Controls are furnished by negative findings in the blood of about 50 normal hogs and in the blood of six animals which became convalescent and finally recovered. Two experiments have been made relative to the horse serum virus phenomenon, which showed the presence of the spirochete in the horse serum virus.

IMMUNITY BACTERIOLOGY

The Relation of the Leucocytic Bacteriolysin to Body Fluids: W. H. Manwaring, Rockefeller Institute for Medical Research.

A bactericidal substance can be extracted from horse leucocytes. This substance is strongly bacteriolytic when dissolved in distilled water and possesses considerable bactericidal power when dissolved in physiological saline. The substance, however, is without bactericidal properties when mixed with sera, with pathological transudates, with cerebro-spinal fluid, or with the products of tissue autolysis, including the products obtained by a prolonged autolysis of leucocytes themselves. The antibactericidal action of body fluids and tissue products depends upon three factors: (1) the antibactericidal power of the colloids they contain, (2) the antibactericidal power of their neutral salts and other neutral diffusible components and (3) the antibactericidal power of their diffusible alkalies. Diffusible acids are apparently without antibactericidal effect. An extract from horse leucocytes can have little or no antiseptic action, when injected into body cavities and tissue spaces.

On Intraperitoneal Lysis of Tubercle Bacilli: W. H. Manwaring and J. Bronfenbrenner, Rockefeller Institute for Medical Research.

If suspensions of tubercle bacilli are injected into the peritoneal cavities of tuberculous guinea-pigs, there takes place a rapid disappearance of the bacilli from the peritoneal fluids, as determined by subsequent examinations by the Ziehl-Neelson method. Nine tenths of the bacilli may disappear within an hour, and all but an occasional bacillus within five hours. This disappearance is paralleled by the appearance of atypical, non-staining and granular forms. After the disappearance numerous granules can be demonstrated in the peritoneal fluids and peritoneal scrapings by the Much method. Before the conclusion can be drawn, however, that the disappearance of the tubercle bacilli is due wholly to their destruction by the peritoneal fluids, such factors as a possible removal of the bacilli by the rapid formation and absorption of peritoneal transudate must be ruled out, as well as the possibility of a spontaneous metamorphosis of the bacilli into non-staining and therefore invisible forms, as described by Much. A similar rapid disappearance is brought about in the peritoneal cavities of tuberculous rats, tuberculous rabbits and tuberculous dogs. The mechanism of the disappearance is now under investigation.

The Chemistry of Anaphylactic Intoxication: BENJAMIN WHITE, Hoagland Laboratory, Brooklyn, N. Y.

The study of the chemical problems involved in the anaphylactic phenomenon would seem to offer a promising field. If this reaction is to be considered as a parenteral digestion of protein, then it may be possible to study the reaction *in vitro*. The work of Vaughan on the poisonous substance obtained from proteins by alkali hydrolysis, the work of Biedl and Kraus and others on the action of proteoses and peptones and the experiments of Rosenow on the products of *Pneumococcus* autolysis, appear to be closely related, and these in turn bear resemblances to the results of experiments on the anaphylatoxin produced in the test tube. Recent studies on the action of the amines, particularly that of B-amid-azolylethylamine, suggests a possible analogy between the action of this class of substances and the substances mentioned above.

Peptotoxin Production by the Bacillus of Contagious Abortion in Cattle:[1] JOHN REICHEL, V.M.D., and MALCOLM J. HARKINS, V.M.D.

The English commission appointed by the Board of Agriculture and Fisheries to inquire into epizootic abortion of cattle, in their report include the statement "apparently, however, no free toxins are formed by the bacillus (abortus) in culture." The reaction in infected cattle, usually appreciable by a rise of temperature, etc., in from eight to eighteen hours after a subcutaneous injection of abortin, *i. e.*, an extract of the bacillus and its products prepared as in tuberculin with tubercle bacilli is generally attributed to toxins of which the English commission remarks, "the toxins, then, which cause the febrile symptoms after inoculation are endotoxins, that is to say, they are contained inside the bacilli." From this it may be taken that the opinion is held that the bacilli in culture form no other toxins than endotoxins. From our experiments we have drawn the following conclusions: (1) The bacillus of contagious abortion of cattle (*abortus bacilli*) produces a toxin on peptonized culture media, but not on peptone-free media. (2) Thorough washing will rid the bacilli grown on peptonized media of the toxin. (3) The toxin is included in the alcoholic precipitate of the supernatant liquid of the suspension of the bacilli grown on peptonized agar. (4) Sixty-five degrees centigrade for thirty minutes apparently had no effect on the peptotoxin. (5) Cattle must be sensitized to react to the peptotoxin. (6) *Bacillus typhosus, coli communis*, tetanus and pneumococcus cultures on peptonized agar reveal the presence of peptotoxin, when injected into animals sensitized to the abortus bacillus or its products. The peptotoxins of these organisms probably have much in common if they are not one and the same substance, because animals can be sensitized with one for any of the others. (7) No reactions were observed following the injections into the sensitized animals of peptonized agar cultures of the diphtheria bacillus, *Staphylococcus aureus*, nonhemolytic streptococcus and hemolytic streptococcus which may mean that these organisms did not produce peptotoxin or only in very small amounts. (8) Rabbits developed agglutinins following the injection of thoroughly washed and unwashed abortus bacilli equally well. The peptotoxin injected with the unwashed bacilli is not essential in the production of antibodies. (9) In that the abortus bacillus produces a peptotoxin in a proteid medium—and it is a possibility that the peptotoxin is produced in milk with the bacilli from cattle in infected herds—the wholesomeness of such milk is more than questionable.

A. PARKER HITCHENS,
Secretary

[1] The Mulford Laboratories, Glenolden, Pa.

SCIENCE

FRIDAY, OCTOBER 3, 1913

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

OLD AND NEW AIMS AND METHODS OF MORPHOLOGY[1]

"ADDRESS your audience about what you yourself happen to be most interested in, speak from the fullness of your heart and make a clean breast of your troubles." That seemed good advice, and I shall endeavor to follow it, taking for my text old and new aims and methods of morphology, with special reference to resemblances in function and structure on the part of organs and their owners in the animal kingdom. First, however, allow me to tell you what has brought me to such a well-worn theme. Amongst the many impressions which it has been my good luck to gather during my travels in that enchanting country Mexico are the two following:

First, the poisonous coral snakes, *Elaps,* in their beautiful black, red and yellow garb; it varies in detail in the various species of *Elaps,* and this garb with most of the variations too, occurs also in an astonishing number of genera and families of semi-poisonous and quite harmless Mexican snakes, some of which inhabit the same districts. A somewhat exhaustive study of these beauties has shown incontestably that these often astoundingly close resemblances are not cases of mimicry, but due to some other cooperations.

Secondly, in the wilds of the state of Michoacan, at two places, about 20 and 70 miles from the Pacific coast, I myself collected specimens of *Typhlops* which Dr.

[1] Address of the president to the Zoological Section of the British Association for the Advancement of Science, Birmingham, 1913.

Boulenger without hesitation has determined as *Typhlops braminus*. Now, whilst this genus of wormlike, blind little snakes has a wide circumtropical distribution, *T. braminus* had hitherto been known only from the islands and countries of the Indian Ocean basin, never from America, nor from any of the Pacific Islands which possess other kinds of *Typhlops*. Accidental introduction is out of the question. Although the genus is, to judge from its characters, an especially old one, we can not possibly assume that the species *braminus*, if the little thing had made its way from Asia to Mexico by a natural mode of spreading, has remained unaltered even to the slightest detail since that geological epoch during which such a journey could have taken place. There remains the assumption that amongst the of course countless generations of *Typhlops* in Mexico some have hit off exactly the same kind of permutation and combination of those characters which we have hitherto considered as specific of *braminus*, just as a pack of cards may in a long series of deals be dealt out more than once in the same sequence.

The two cases are impressive. They reminded me vividly that many examples of very discontinuous distribution—which any one who has worked at zoogeography will call to mind—are exhibited by genera, families, and even orders, without our knowing whether the groups in which we class them are natural or artificial. The ultimate appeal lies with anatomy.

Introduced to zoology when Haeckel and Gegenbaur were both at their zenith, I have been long enough a worker and teacher to feel elated by its progress and depressed by its shortcomings and failures. Perhaps we have gone too fast, carried along by methods which have yielded so much and therefore have made us expect too much from them.

Gegenbaur founded the modern comparative anatomy by basing it upon the theory of descent. The leading idea in all his great works is to show that transformation, "continuous adjustment" (Spencer), has taken place; he stated the problem of comparative anatomy as the reduction of the differences in the organization of the various animals to a common condition; and as homologous organs he defined those which are of such a common, single origin. His first work in this new line is his classical treatise on the carpus and tarsus (1864).

It followed from this point of view that the degree of resemblance in structure between homologous organs and the number of such kindred organs present is a measure for the affinity of their owners. So was ushered in the era of pedigrees of organs, of functions, of the animals themselves. The tracing of the divergence of homogenous parts became all-important, whilst those organs or features which revealed themselves as of different origin, and therefore as analogous only, were discarded as misleading in the all-important search for pedigrees. Functional correspondence was dismissed as "mere analogy," and even the systematist has learned to scorn these so-called physiological or adaptive characters as good enough only for artificial keys. A curious view of things, just as if it was not one and the same process which has produced and abolished both sets of characters, the so-called fundamental or "reliable" as well as the analogous.

As A. Willey has put it happily, there was more rejoicing over the discovery of the homology of some unimportant little organ than over the finding of the most

appalling unrelated resemblance. Morphology had become somewhat intolerant in the application of its canons, especially since it was aided by the phenomenal growth of embryology. You must not compare ectodermal with endodermal products. You must not make a likeness out of another germinal layer or anything that appertains to it, because if you do that would be a horror, a heresy, a homoplasy.

Haeckel went so far as to distinguish between a true homology, or homophyly, which depends upon the same origin, and a false homology, which applies to all those organic resemblances which derive from an equivalent adaptation to similar developmental conditions. And he stated that the whole art of the morphologist consists in the successful distinction between these two categories. If we were able to draw this distinction in every case, possibly some day the grand tree of each great phylum, may be of the whole kingdom, might be reconstructed. That would indeed be a tree of knowledge, and, paradoxically enough, it would be the deathblow to classification, since in this, the one and only true natural system, every degree of consanguinity and relationship throughout all animated nature, past and present, would be accounted for; and to that system no classification would be applicable, since each horizon would require its own grouping. There could be definable neither classes, orders, families nor species, since each of these conceptions would be boundless in an upward or downward direction.

Never mind the ensuing chaos; we should at least have the pedigree of all our fellow creatures, and of ourselves among them. Not absolute proof, but the nearest possible demonstration that transformation has taken place. Empirically we know this already, since, wherever sufficient material has been studied, be it organs, species or larger groups, we find first that these units had ancestors and, secondly, that the ancestors were at least a little different. Evolution is a fact of experience proved by circumstantial evidence. Nevertheless we are not satisfied with the conviction that life is subject to an unceasing change, not even with the knowledge of the particular adjustments. We now want to understand the motive cause. First What, then How and now Why?

It is the active search for an answer to this question (Why?) which is characteristic of our time. More and more the organisms and their organs are considered as living, functional things. The mainspring of our science, perhaps of all science, is not its utility, not the desire to do good, but, as an eminently matter-of-fact man, the father of Frederick the Great, told his Royal Academicians (who, of course, were asking for monetary help) in the following shockingly homely words: "Der Grund ist derer Leute ihre verfluchte Curieusiteit." This blamed curiosity, the beginnings of which can be traced very far back in the lower animals, is most acutely centered in our desire to find out who we are, whence we have come, and whither we shall go. And even if zoology, considering the first and last of these three questions as settled, should some day solve the problem: Whence have we come? there would remain outside zoology the greater Why?

Generalizations, conclusions, can be arrived at only through comparison. Comparison leads no further where the objects are alike. If, for instance, we restrict ourselves to the search for true homologies, dealing with homogenes only, all we find is that once upon a time some organism has produced, invented, a certain arrangement of *Anlage* out of which that organ arose, the various features of which we have compared in the descendants. Result: we

have arrived at an accomplished fact. These things, in spite of all their variety in structure and function, being homogenes, tell us nothing, because according to our mode of procedure we can not compare that monophyletic *Anlage* with anything else, since we have reduced all the homogenous modifications to one. Logically it is true that there can have been only one, but in the living world of nature there are no such ironbound categories and absolute distinctions. For instance, if we compare the organs of one and the same individual, we at once observe repetition, *e. g.*, that of serial homology, which implies many difficulties, with very different interpretations. Even in such an apparently simple case as the relation between shoulder girdle and pelvis we are at a loss, since the decision depends upon our view as to the origin of the paired limbs, whether both are modified visceral arches, and in this case serially repeated homogenes, or whether they are the derivatives from one lateral fin, which is itself a serial compound, from which, however, the proximal elements, the girdles, are supposed to have arisen independently. What is metamerism? Is it the outcome of a process of successive repetitions so that the units are homogenes, or did the division take place at one time all along the line, or is it due to a combination of the two procedures?

The same vagueness finds its parallel when dealing with the corresponding organs of different animals, since these afford the absolute chance that organs of the same structure and function may not be reducible to one germ, but may be shown to have arisen independently in time as well as with reference to the space they occupy in their owners. As heterogenes they can be compared as to their causes. In the study of the evolution of homogenes the problem is to account for their divergencies, whilst the likeness, the agreements, so to speak their greatest common measure, is *eo ipso* taken to be due to inheritance. When, on the contrary, dealing with heterogenes we are attracted by their resemblances, which since they can not be due to inheritance must have a common cause outside themselves. Now, since a leading feature of the evolution of homogenes is divergence, whilst that of heterogenes implies convergence from different starting-points, it follows that the more distant are these respective starting-points (either in time or in the material) the better is our chance of extracting the greatest common measure out of the unknown number of causes which combine in the production of even the apparently simplest organ.

These resemblances are a very promising field and the balance of importance will more and more incline towards the investigation of function, a study which, however, does not mean mere physiology with its present-day aims in the now tacitly accepted sense, but that broad study of life and death which is to yield the answer to the question Why?

Meantime, comparative anatomy will not be shelved; it will always retain the casting-vote as to the degree of affinity among resemblances, but emphatically its whole work is not to be restricted to this occupation. It will increasingly have to reckon with the functions, indeed never without them. The animal refuses to yield its secrets unless it be considered as a living individual. It is true that Gegenbaur himself was most emphatic in asserting that an organ is the result of its function. Often he held up to scorn the embryographer's method of muddling cause and effect, or he mercilessly showed that in the reconstruction of the evolution of an organ certain features can not have been phases unless they imply physiological continuity.

And yet how moderately is function dealt with in his monumental text-book and how little is there in others, even in text-books of zoology:

> Habt alle die Theile in der Hand,
> Fehlt leider nur das geistige Band—Life!

We have become accustomed to the fact that like begets like with small differences, and from the accepted standpoint of evolution versus creation we no longer wonder that descendants slowly change and diverge. But we are rightly impressed when unlike comes to produce like, since this phenomenon seems to indicate a tendency, a set purpose, a *beau idéal,* which line of thought or rather imperfect way of expression leads dangerously near to the crassest teleology.

But, teleology apart, we can postulate a perfect agreement in function and structure between creatures which have no community of descent. The notion that such agreement *must* be due to blood-relationship involved, among other difficulties, the dangerous conclusion that the hypothetical ancestor of a given genuine group possessed in potentiality the *Anlagen* of all the characters exhibited by one or other of the component members of the said group.

The same line of thought explained the majority of human abnormalities as atavistic, a procedure which would turn the revered ancestor of our species into a perfect museum of antiquities, stocked with tools for every possible emergency.

The more elaborate certain resemblances are the more they seem to bear the hallmark of near affinity of their owners. When occurring in far-related groups they are taken at least as indications of the homology of the organs. There is, for instance, a remarkable resemblance between the *bulla* of the whale's ear and that of the *Pythonomorph plioplatycarpus.* If you homologize the mammalian tympanic with the quadrate the resemblance loses much of its perplexity, and certain Chelonians make it easier to understand how the modification may have been brought about. But, although we can arrange the Chelonian, Pythonomorph and Cetacean conditions in a progressive line, this need not represent the pedigree of this *bulla.* Nor is it necessarily referable to the same *Anlage.* Lastly if, as many anatomists believe, the reptilian quadrate appears in the mammals as the *incus,* then all homology and homogeny of these *bullæ* is excluded. In either case we stand before the problem of the formation of a *bulla* as such. The significant point is this, that although we dismiss the *bulla* of whale and reptile as obvious homoplasy, such resemblances, if they occur in two orders of reptiles, we take as indicative of relationship until positive evidence to the contrary is produced. That this is an unsound method is brought home to us by an ever-increasing number of cases which tend to throw suspicion on many of our reconstructions. Not a few zoologists look upon such cases as a nuisance and the underlying principle as a bugbear. So far from that being the case such study promises much beyond the pruning of our standard trees—by relieving them of what reveal themselves as grafts instead of genuine growth—namely, the revelation of one or other of the many agencies in their growth and structure.

Since there are all sorts and conditions of resemblances we require technical terms. Of these there is abundance, and it is with reluctance that I propose adding to them. I do so because unfortunately some terms are undefined, perhaps not definable; others have not "caught on," or they suffer from that mischievous law of priority in nomenclature.

The terms concerning morphological

homologies date from Owen; Gegenbaur and Haeckel rearranged them slightly. Lankester, in 1870, introduced the terms homogenous, meaning alike born, and homoplastic or alike molded. Mivart rightly found fault with the detailed definition and the subdivisions of homoplasy, and very logically invented dozens of new terms, few of which, if any, have survived. It is not necessary to survey the ensuing literature. For expressing the same phenomenon we have now the choice between homoplasy, homomorphy, isomorphy, heterophyletic convergence, parallelism, etc. After various papers by Osborn, who has gone very fully into these questions, and Willey's "Parallelism," Abel, in his fascinating "Grundzüge der Palæobiologie," has striven to show by numerous examples that the resemblances or "adaptive formations" are cases of parallelism if they depend upon the same function of homologous organs, and convergences if brought about by the same function of non-homologous organs.

I suggest an elastic terminology for the various resemblances indicative of the degree of homology of the respective organs, the degree of affinity of their owners, and lastly the degree of the structural likeness attained.

Homogeny.—The structural feature is invented once and is transmitted, without a break, to the descendants, in which it remains unaltered, or it changes by mutation or by divergence, neither of which changes can bring the ultimate results nearer to each other. Nor can their owners become more like each other since the respective character made its first appearance either in one individual, or, more probably, in many of one and the same homogeneous community.

Homoplasy.—The feature or character is invented more than once, and independently. This phenomenon excludes absolute identity; it implies some unlikeness due to some difference in the material, and there is further the chance of the two or more inventions, and therefore also of their owners, becoming more like each other than they were before.

CATEGORIES OF HOMOPLASY

Isotely.—If the character, feature or organ has been evolved out of homologous parts or material, as is most likely the case in closely related groups, and if the subsequent modifications proceed by similar stages and means, there is a fair probability or chance of very close resemblance. *Isotely:* the same mark has been hit.

Homœotely.—Although the feature has been evolved from homologous parts or material, the subsequent modifications may proceed by different stages and means, and the ultimate resemblance will be less close, and deficient in detail. Such cases are most likely to happen between groups of less close affinity, whether separated by distance or by time. *Homœo-tely:* the same end has been fairly well attained. The target has been hit, but not the mark.

Parately.—The feature has been evolved from parts and material so different that there is scarcely any or no relationship. The resulting resemblance will at best be more or less superficial; sometimes a sham, although appealing to our fancy. *Parately:* the neighboring target has been hit.

EXAMPLES

Isotely:

- Bill of the *Ardeidæ balæniceps* (Africa) and *Cancroma* (tropical America).
- Zygodactyle foot of *Cuckoos, Parrots, Woodpeckers* (2·3/1·4).
- Patterns and coloration of *Elaps* and other snakes.
- Parachute of *Petaurus* (marsupial); *Pteromys* (rodent) and *Galeopithecus.*
- Perissodactylism of *Litopterna* and Hippoids.

Bulla auris of *Plioplatecarpus* (*Pythonomorphe*) and certain whales; if tympanic = quadrate.

Grasping instruments or nippers in Arthropods: pedipalps of *Phryne;* chelæ of squill; first pair of mantis's legs.

General appearance of moles and *Notoryctes,* if both considered as mammals; of gulls and petrels, if considered as birds.

Homœotely:

Heterodactyle foot of trogons (3·4/2·1).

Jumping foot of *Macropus, Dipus, Tarsius.*

Intertarsal and cruro-tarsal joint.

Fusion and elongation of the three middle metatarsals of *Dipus* and *Rhea.*

Paddles of ichthyosaurs. Turtles, whales, penguins.

"Wings" of pterosaurs and bats.

Long flexible bill of *Apteryx* and snipes.

Proteroglyph dentition of cobras and solenoglyph dentition of vipers.

Loss of the shell of *Limax* and *Aplysia.*

Complex molar pattern of horse and cow.

Parately:

Bivalve shell of brachiopods and lamellibranchs.

Stretcher-sesamoid bone of pterodactyls (radial carpal); of flying squirrels (on pisiform); of *Anomalurus* (on olecranon).

Bulla auris of pythonomorph (quadrate) and whale (tympanic); is *incus* = quadrate.

"Wings" of pterosaurs, or bats, and birds.

The distinction between these three categories must be vague because that between homology and analogy is also arbitrary, depending upon the standpoint of comparison. As lateral outgrowths of vertebræ all ribs are homogenes, but if there are at least hæmal and pleural ribs then those organs are not homologous even within the class of fishes. If we trace a common origin far enough back we arrive near bedrock with the germinal layers. So there are specific, generic, ordinal, etc., homoplasies. The potentiality of resemblance increases with the kinship of the material.

Bateson, in his study of homœosis, has rightly made the solemn quotation: "There is the flesh of fishes . . . birds . . . beasts, etc." Their flesh will not and can not react in exactly the same way under otherwise precisely the same conditions, since each kind of flesh is already biased, encumbered by inheritances. If a certain resemblance between a reptile and mammal dates from Permian times, it may be homogenous, like the pentadactyle limb which as such has persisted; but if that resemblance has first appeared in the Cretaceous period it is homoplastic, because it was brought about long after the class division. To cases within the same order we give the benefit of the doubt more readily than if the resemblance concerned members of two orders, and between the phyla we rightly seek no connection. However, so strongly is our mode of thinking influenced by the principle of descent that, if the same feature happen to crop up in more than two orders, we are biased against homoplasy.

The readiness with which certain homoplasies appear in related groups seems to be responsible for the confounding of the potentiality of convergent adaptation with a latent disposition, as if such cases of homoplasy were a kind of temporarily deferred repetition, *i. e.,* after all due to inheritance. This view instances certain recurring tooth patterns, which, developing in the embryonic teeth, are said not to be due to active adaptation or acquisition but to selection of accomplished variations, because it is held inconceivable that use, food, etc., should act upon a finished tooth. It is not so very difficult to approach the solution of this apparently contradictory problem. Teeth, like feathers, can be influenced long before they are ready by the life experiences of their predecessors. A very potent factor in the evolution of homoplasies is correlation, which is sympathy, just as inheritance is reminiscence. The introduction of a single new feature may affect the whole organism profoundly, and one serious case of isotely may arouse un-

suspected correlations and thus bring ever so many more homoplasies in its wake.

Function is always present in living matter; it is life. It is function which not only shapes, but creates the organ or suppresses it, being indeed at bottom a kind of reaction upon some stimulus, which stimuli are ultimately all fundamental, elementary forces, therefore few in number. That is a reason why nature seems to have but few resources for meeting given "requirements"—to use an everyday expression, which really puts the cart before the horse. This paucity of resources shows itself in the repetition of the same organs in the most different phyla. The eye has been invented dozens of times. Light, a part of the environment, has been the first stimulus. The principle remains the same in the various eyes; where light found a suitably reacting material a particular evolution was set going, often round about, or topsy-turvy, implying amendments; still, the result was an eye—in advanced cases a scientifically constructed dark chamber with lens, screen, shutters and other adjustments. The detail may be unimportant, since in the various eyes different contrivances are resorted to.

Provided the material is suitable, plastic, amenable to prevailing environmental or constitutional forces, it makes no difference what part of an organism is utilized to supply the requirements of function. You can not make a silk purse out of a sow's ear, but you can make a purse, and that is the important point. The first and most obvious cause is function, which itself may arise as an incidental action due to the nature of the material. The oxidizing of the blood is such a case, and respiratory organs have been made out of whatever parts invite osmotic contact of the blood with air or water. It does not matter whether respiration is carried on by ecto- or by endodermal epithelium. Thus are developed internal gills, or lungs, both of which may be considered as referable to pharyngeal pouches; but where the outer skin has become suitably osmotic, as in the naked Amphibia, it may evolve external gills. Nay, the whole surface of the body may become so osmotic that both lungs and gills are suppressed, and the creature breathes in a most pseudo-primitive fashion. This arrangement, more or less advanced, occurs in many Urodeles, both American and European, belonging to several subfamilies, but not in every species of the various genera. It is therefore a case of apparently recent isotely.

There is no prejudice in the making of a new organ except in so far that every organism is conservative, clinging to what it or its ancestors have learned or acquired, which it therefore seeks to recapitulate. Thus in the vertebrata the customary place for respiratory organs is the pharyngeal region. Every organism, of course, has an enormous back history; it may have had to use every part in every conceivable way, and it may thereby have been trained to such an extent as to yield almost at once, like a bridle-wise horse to some new stimulus, and thus initiate an organ straight to the point.

Considering that organs put to the same use are so very often the result of analogous adaptation, homoplasts with or without affinity of descent, are we not justified in accusing morphology of having made rather too much of the organs as units, as if they were concrete instead of inducted abstract notions? An organ which changes its function may become a unit so different as to require a new definition. And two originally different organs may come to resemble each other so much in function and structure that they acquire the same definition as one new unit. To avoid this

dilemma the morphologist has, of course, introduced the differential of descent, whether homologous or analogous, into his diagnoses of organs.

The same principles must apply to the classification of the animals. To group the various representative owners of cases of isotely together under one name, simply because they have lost those characters which distinguished their ancestors, would be subversive of phyletic research. It is of the utmost significance that such "convergences" (rather "mergers," to use an administrative term) do take place, but that is another question. If it could be shown that elephants in a restricted sense have been evolved independently from two stems of family rank, the convergent terminals must not be named *Elephantinæ*, nor can the representatives of successive stages or horizons of a monophyletic family be designated and lumped together as subfamilies. And yet something like this practise has been adopted from Cope by experienced zoologists with a complete disregard of history, which is an inalienable and important element in our science.

This procedure is no sounder than would be the sorting of our Cartwrights, Smiths and Bakers of sorts into as many natural families. It would be subversive of classification, the aim of which is the sorting of a chaos into order. We must not upset the well-defined relative meaning of the classificatory terms which have become well-established conceptions; but what such an assembly as the terminal elephants should be called is a new question, the urgency of which will soon become acute. It applies at least to assemblies of specific, generic and family rank, for each of which grades a new term, implying the principle of convergence, will have to be invented. In some cases geographical terms may be an additional criterion. Such terms will be not only most convenient, but they will at once act as a warning not to use the component species for certain purposes. There is, for instance, the case of *Typhlops braminus*, mentioned at the beginning of this address. Another case is the dog species, called *Canis familiaris*, about which it is now the opinion of the best authorities that the American dogs of sorts are the descendants of the coyote, while some Indian dogs are descendants of a jackal, and others again are traceable to some wolf. The "dog," a definable conception, has been invented many times, and in different countries and out of different material. It is an association of converged hetergeneous units. We have but a smile for those who class whales with fishes, or the blindworm with the snakes; not to confound the amphibian Cœcilians with reptilian *Amphisbænas* requires some training; but what are we to do with creatures who have lost or assimilated all those differential characters which we have got used to rely upon?

In a homogeneous crowd of people we are attracted by their little differences, taking their really important agreements for granted; in a compound crowd we at once sort the people according to their really unimportant resemblances. That is human nature.

The terms "convergence" and "parallelism" are convenient if taken with a generous pinch of salt. Some authors hold that these terms are but imperfect similes, because two originally different organs can never converge into one identical point, still less can their owners whose acquired resemblance depresses the balance of all their other characters. For instance, no lizard can become a snake, in spite of ever so many additional snake-like acquisitions, each of which finds a parallel, an analogy in the snakes. Some zoologists therefore prefer contrasting only parallelism and

divergence. A few examples may illustrate the justification of the three terms. If out of ten very similar black-haired people only two become white by the usual process, whilst the others retain their color, then these two diverge from the rest; but they do not, by the acquisition of the same new feature, become more alike each other than they were before. Only with reference to the rest do they seem to liken as they pass from black through gray to white, our mental process being biased by the more and more emphasized difference from the majority.

10 Ax Bx Cx D E F
9
8
7
6
5
4
3
2 Ax Bx
1 A B C D E F

Supposing A and B both acquire the character X and this continues through the next ten generations, while in the descendants of C the same character is invented in the tenth generation, and whilst the descendants of D, E, F still remain unaltered. Then we should be strongly inclined, not only to key together $C(x/10)$ with A $(x/10)$ and $B(x/10)$, but take this case for one of convergence, although it is really one of parallelism. If it did not sound so contradictory it might be called parallel divergence. The inventors diverge from the majority in the same direction: Isotely.

Third case: Ten people, contemporaries, are alike but for the black or red hair. Black A turns white and Red E turns white, not through exactly identical stages, since E will pass through a reddish gray tinge. But the result is that A and E become actually more like each other than they were before. They *converge,* although they have gone in for exactly the same divergence with reference to the majority.

In all three cases the variations begin by divergence from the majority, but we can well imagine that all the members of a homogeneous lot change orthogenetically (this term has been translated into the far less expressive "rectigrade") in one direction, and if there be no lagging behind, they all reach precisely the same end. This would be a case of transmutation (true mutations in Waagen's and Scott's sense), producing new species without thereby increasing their number, whilst divergence always implies, at least potentially, increase of species, genera, families, etc.

If for argument's sake the mutations pass through the colors of the spectrum and if each color be deemed sufficient to designate a species, then, if all the tenth generations have changed from green to yellow and those of the twentieth generation from yellow to red, the final number of species would be the same. And even if some lagged behind, or remained stationary, these epistatic species (Eimer) are produced by a process which is not the same as that of divergence or variation in the usual sense.

The two primary factors of evolution are environment and heredity. Environment is absolutely inseparable from any existing organism, which therefore must react (adaptation) and at least some of these results gain enough momentum to be carried into the next generation (heredity).

The life of an organism, with all its experiments and doings, is its ontogeny, which may therefore be called the subject of evolution, but not a factor. Nor is selection a primary and necessary factor, since, being destructive, it invents nothing. It accounts, for instance, for the composition of the present fauna, but has not made its components. A subtle scholastic insinu-

ation lurks in the plain statement that by ruthless elimination a black flock of pigeons can be produced, even that thereby the individuals have been made black. (But of course the breeder has thereby not invented the black pigment.)

There can be no evolution, progress, without response to stimulus, be this environmental or constitutional, *i. e.*, depending upon the composition and the correlated working of the various parts within the organism. Natural selection has but to favor this plasticity, by cutting out the non-yielding material, and through inheritance the adaptive material will be brought to such a state of plasticity that it is ready to yield to the spur of the moment, and the foundation of the same new organs will thereby be laid, whenever the same necessity calls for them. Here is a dilemma. On the one hand the organism benefits from the ancestral experience, on the other there applies to it de Rosa's law of the reduction of variability, which narrows the chances of change into fewer directions. But in these few the changes will proceed all the quicker and farther. Thus progress is assured, even hypertely, which may be rendered by "overdoing a good thing."

Progress really proceeds by mutations, spoken of before, orthogenesis, and it would take place without selection and without necessarily benefiting the organism. It would be mere presumption that the seven-gilled shark is worse off than its six- or five-gilled relations; or to imagine that the newt with double trunk-veins suffers from this arrangement, which morphologically is undoubtedly inferior to the unpaired, azygous, etc., modifications. The fact that newts exist is proof that they are efficient in their way. Such orthogenetic changes are as predictable in their results as the river which tends to shorten its course to the direct line from its head waters to the sea. That is, the river's entelechy is no more due to purpose or design than is the series of improvements from the many gill-bearing partitions of a shark to the fewer, and more highly finished comb-shaped gills of a Teleostean fish.

The success of adaptation, as measured by the morphological grade of perfection reached by an organ, seems to depend upon the phyletic age of the animal when it was first subjected to these "temptations." The younger the group, the higher is likely to be the perfection of an organic system, organ or detail. This is not a platitude. The perfection attained does not depend merely upon the length of time available for the evolution of an organ. A recent Teleostean has had an infinitely longer time as a fish than a reptile, and this had a longer time than a mammal, and yet the same problem is solved in a neater, we might say in a more scientifically correct way by a mammal than by a reptile, and the reptile in turn shows an advance in every detail in comparison with an amphibian, and so forth.

A few examples will suffice:

The claws of reptiles and those of mammals; there are none in the amphibians, although some seem to want them badly, like the African frog *Gampsosteonyx*, but its cat-like claws, instead of being horny sheaths, are made out of the sharpened phalangeal bones which perforate the skin.

The simple contrivance of the rhinocerotic horn, introduced in Oligocene times, compared with the antlers of Miocene *Cervicornia* and these with the response made by the latest of Ruminants, the hollow-horned antelopes and cattle. The heel-joint; unless still generalized, it tends to become intertarsal (attempted in some lizards, pronounced in some dinosaurs and in the birds) by fusion of the bones of the

tarsus with those above and below, so that the tarsals act like epiphysial pads. Only in mammals epiphyses are universal. Tibia and fibula having their own, the pronounced joint is cruro-tarsal and all the tarsals could be used for a very compact, yet non-rigid arrangement. The advantage of a cap, not merely the introduction of a separate pad, is well recognized in engineering.

Why is it that mammalian material can produce what is denied to the lower classes? In other words, why are there still lower and middle classes? Why have they not all by this time reached the same grade of perfection? Why not indeed, unless because every new group is less hampered by tradition, much of which must be discarded with the new departure; and some of its energy is set free to follow up this new course, straight, with ever-growing results, until in its turn this becomes an old rut out of which a new jolt leads once more into fresh fields.

H. F. Gadow

THE NEW RELATIVITY IN PHYSICS

Ever since Newton's corpuscular theory of light was supplanted, early in the nineteenth century, by the theory that light travels in waves through ether as sound through air, physicists have been endeavoring to obtain direct experimental evidence about this invisible, imponderable ether.

The earth sweeps through space with a velocity of about 2,000 miles a minute; if ether fills all space, it should be possible with the delicate instruments now in our possession to detect an ether drift, an optical effect caused by the motion of the earth through the ether.

Among others, Professors Michelson and Morley[1] tried to detect this ether drift experimentally, but obtained purely negative results. Although they failed to get evidence of an ether, they did obtain new physical facts of an even greater importance, which have caused us to readjust our concepts of space and time.

Let us assume that the sun and earth are at rest in space; it then takes a beam of light about eight minutes to travel through space from the sun to the earth.

If we assume that both sun and earth are in uniform translation through space, that is, that both are in motion along the same straight line, we would expect, since the velocity of light can not be increased or diminished by motion of its source, that a light beam would be longer on its way from sun to earth when it travels in the direction of the motion, and that the light beam would be a shorter time on its way when it travels counter to the motion; in traveling with the motion the light beam would overtake the earth; when the direction of the motion is reversed, earth and light flash would meet.

These deductions, according to the principle of relativity, are not valid, for the facts presented by Michelson's experiments show us that the number of seconds that a light flash is on its way can neither be increased nor diminished when the interstellar space through which the light has to travel is arbitrarily increased or diminished by giving source and observer the same uniform translation.

Newton based his mechanics upon *absolute* space and time,[2] "not that which the vulgar associate with sensible objects." Clerk Maxwell[3] said: "All our knowledge, both of time and place, is essentially relative." Yet he could not free himself from the Newtonian mechanics, and it was not until 1905 that Albert Einstein[4] repudiated the word *absolute*, and out of the "vulgar" ideas of space and time developed the modern theory of relativity. Einstein was then an employee in the patent office at Bern, and it is but fitting that in Switzerland, which has furnished the world with so many timepieces, new thoughts with

[1] *Silliman's Journal*, 34: 337, 1887.

[2] Newton, "Principia," 1: 8, 1822.

[3] Maxwell, "Matter and Motion," p. 30 (Van Nostrand ed., 1892).

[4] *Annalen der Physik*, 17: 905, 1905; *Jahrbuch der Radioaktivitaet und Electronik*, 4: 411, 1907.

respect to the measurement of time should crystallize, and a new time concept be found.

Any regular process of nature may serve as a measure of time; for example, the fall of sand in the hour-glass, the swing of the pendulum, the sun dial, or to be more modern, an ideal watch which is regulated by a perfect spring and balance wheel. Let us imagine we have two perfect watches, one in San Francisco, the other in New York. How can we synchronize or set them so that both will indicate the same instant of time? To synchronize them both at the factory, and send one to New York and the other to San Francisco, will not do, as we shall see later. Since experiment appears to justify the assumption that the velocity of light through interstellar space is always the same, let us use a light flash to synchronize the watch at San Francisco with the one at New York.

At twelve o'clock the observer in New York sends a light flash to San Francisco, where a mirror immediately reflects it back to him; he finds it took thirty thousandths of a second for the light signal to travel to San Francisco and back; he reasons, therefore, that it took fifteen thousandths of a second to travel one way; he then writes the observer in San Francisco to set his watch at twelve o'clock plus fifteen thousandths of a second, as soon as the light flash again sent from New York at twelve o'clock reaches him; the two watches are then in synchronism for observers at these two stations. The simultaneity of an occurrence at New York with one at San Francisco can then be established by the two synchronized watches. The connotation of the word *simultaneity* thus becomes very definite.

In order to bring out nature's facts with regard to time and space, which Einstein has so clearly presented in mathematical form, we have built a model, constructed briefly, as follows: A triple lead-screw, eight feet long, gives motion to the upper or moving system when the crank at the right of the model is in motion. By throwing in the proper gearing at the crank shaft, a second lead-screw supplies motion (toward right or left) to a light particle (L), in the model, a pocket electric lamp resting upon a traveling nut. Two worm wheels meshing with the first lead-screw operate the hands of the lower or stationary clocks, while a pair of spur gear acting as pinions upon a stationary rack move the clock hands of the system in translation when the latter is in motion.

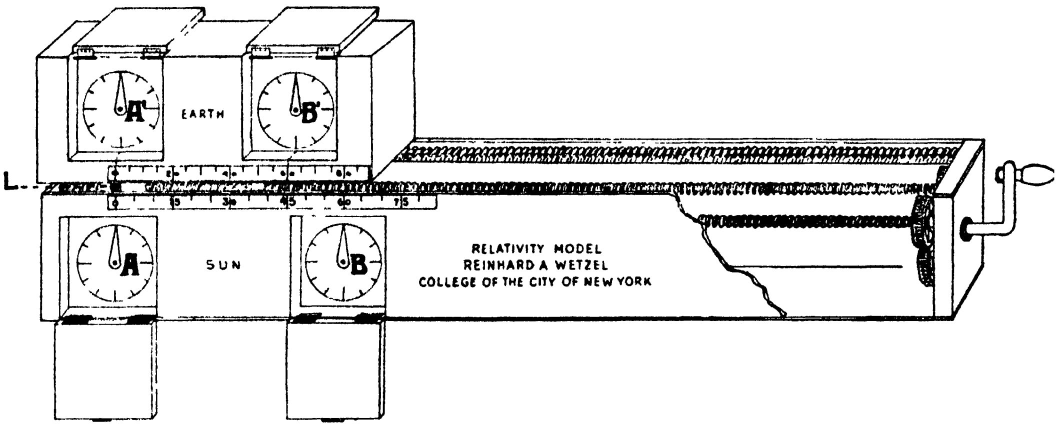

Fig. 1

Following the method of Emil Cohn, of Strassburg,[6] we shall speak of the stationary system as the sun; the two sun clocks are fixed to the sun and are sixty sun miles apart; at each clock station is an observer, sun-man A at the zero station, and sun-man B at the sixty-mile station.

[6] "Himmel und Erde," 23: 117, 1911.

Similarly the moving system may represent an earth always in uniform translation with respect to the sun. At two stations upon the earth sixty earth miles apart are fixed a clock and an observer. A sun-man can see only one earth clock and earth-man at one time,

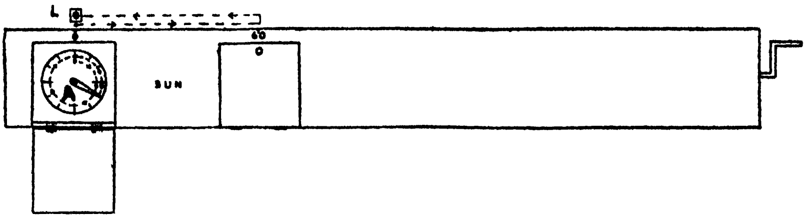

FIG. 2

namely, at the instant earth-man passes sun-man, and *vice versa*. Also, only at the instant an earth-man passes a sun-man can

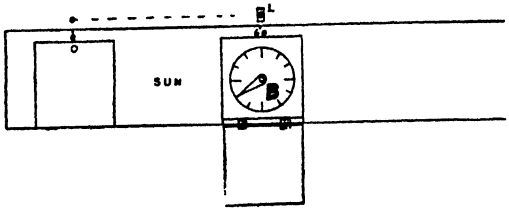

FIG. 3

either make an observation and a comparison of the length and time standards used upon sun and earth.

light particle in the ratio of two to three. We must, therefore, interpret our model as a magnifier of nature's facts with respect to space and time.

Suppose *A* and *B* upon the sun wish to synchronize their two clocks which are exactly alike in every respect and perfect mechanisms. When *A*'s clock reads 12 (Fig. 2), he sends out the light signal which, reflected by the mirror at the 60-mile station, returns after the hand of *A*'s clock has moved through 12 + 4, or 16 hours. Assuming that it took the light signal eight hours to go one way, *A* writes *B* to be on the lookout; the light signal will again leave at 12 and should reach *B* at 8 (Fig. 3). When the signal arrives, *B* sets the hand of his clock at 8, and the two clocks are now in synchronism, and may be used by both observers to establish simultaneous moments of time.

The course pursued by *A* and *B* upon the sun at rest is followed by A^1 and B^1 upon the

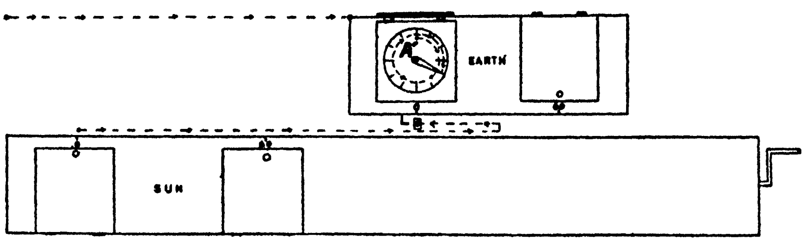

FIG. 4

As the naturalist's picture of a microorganism misrepresents nature as to size, so our model is, in this respect, also a "nature-faker." The orbital velocity of our earth is to the speed of light in interstellar space as one is to ten thousand; but the model arbitrarily represents the earth's velocity to the velocity of the

earth in motion. With their own foot rule A^1 and B^1 have placed their two clocks sixty miles apart, and they too (Fig. 4) find that sixteen hours is required for the passage of the light signal from A^1 to B^1 and return, and that B^1 must set the hand of his clock at 8 (Fig. 5) when the light signal sent by A^1 at 12 reaches

him, in order to set their clocks in synchronism.

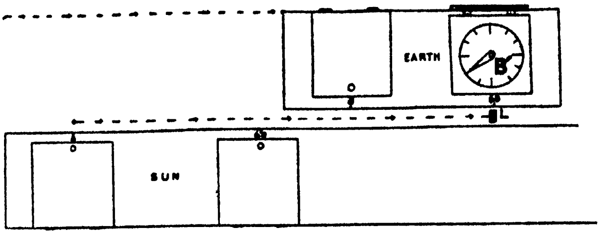

FIG. 5

We are now in a position to measure the velocity of light in both systems, and find that in each case it is 60/8. We can readily believe that all of nature's laws in general, and the velocity of light in particular, should be the same on sun, earth or planet in the Milky Way; but the fact that the earth-man finds the sun clocks slow, and the sun-man finds the earth clocks slow, in the same ratio is the startling contribution of the theory of relativity: that two actions simultaneous upon one system should not be simultaneous when viewed from another system is surprising.

Let us see what the two observers on the sun have to tell us about one of the clocks on the earth.

A and *B* are sixty miles apart and can not both see the earth clock at the same time; but the earth is a moving system, hence *A* can compare his clock with the earth clock, and later *B* can make a similar comparison.

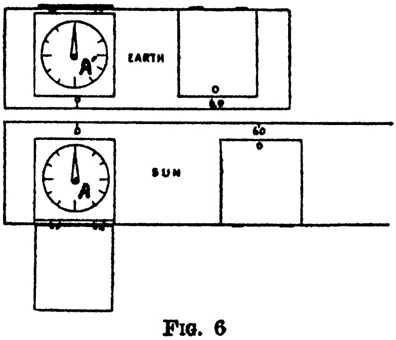

FIG. 6

When the earth clock is opposite *A* (Fig. 6), the latter finds the hand of his clock at 12, and the hand of the earth clock at 12; as the earth moves on, the earth clock of A^1 will reach a position opposite *B* (Fig. 7), who finds that the hand of his clock has again reached 12, while the hand of the earth clock has reached only 9; hence *A* and *B* establish the fact that twelve hours on the sun are equal to nine hours on the earth; that is, the earth clock runs slow in the ratio of 3 to 4.

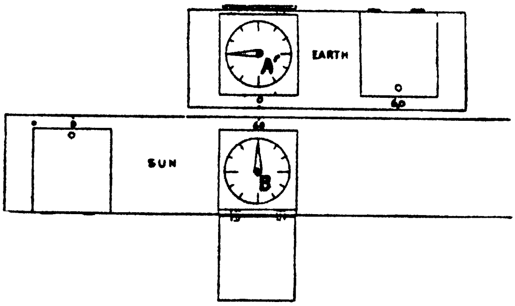

FIG. 7

When the earth-men agree to make observations on one of the sun clocks, they reach a similar conclusion. A^1 and B^1 are sixty miles apart and can not both see the sun clock at the same time; when B^1 comes to a position opposite the sun clock (Fig. 8), the hand of

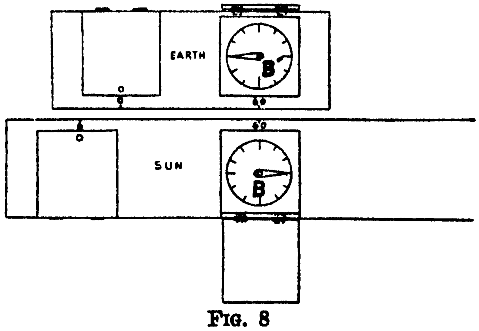

FIG. 8

his clock is at 9, while the hand of the sun clock is at 3; when, as the earth moves on, A^1 comes opposite the sun clock (Fig. 9), he finds that twelve hours have elapsed, for the hand of his clock is again at 9, but the hand of the sun clock has only gone from 3 to 12; in other

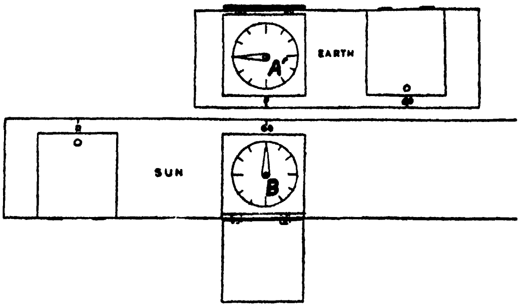

FIG. 9

words, nine hours have elapsed on the sun; hence A^1 and B^1 establish the fact that twelve hours on the earth are equal to nine hours on the sun; that is, the sun clock runs slow in the ratio of 3 to 4.

Since the sun-men and the earth-men make exactly similar statements, each finding the other slow in the ratio of 3 to 4, we must logically conclude that the earth and sun clocks are in reality equivalent, and establish the same unit of time.

The standard of length upon the sun seems, moreover, to be different from that used upon the earth (Fig. 10), but that too is true from

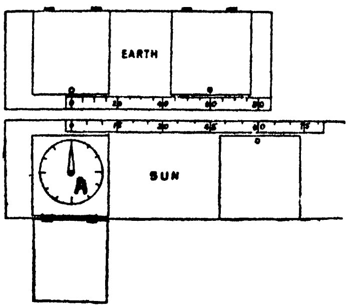

FIG. 10

one view-point (one coordinate system) only; the standards of length as well as of time are in reality equivalent, as we will now proceed to demonstrate.

Let us remember that simultaneity is established only by the clocks.

The sun-men wish to compare their length standard with the standard used upon the earth. The lengths they wish to compare are such that two observers are necessary, one at each end of the scale. A and B decide to compare their scale reading with the scale reading opposite them at the same moment of time. At 12 o'clock A (Fig. 10) finds zero of his scale opposite zero on the earth's scale; B watching his clock finds, when the hand is at 12 (Fig. 11), that 60 on his scale is oppo-

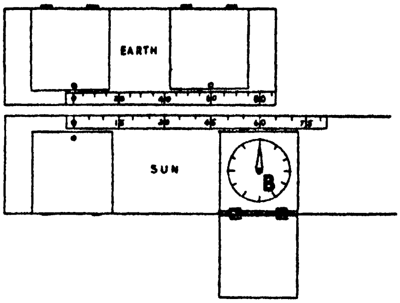

FIG. 11

site 80 on the earth's scale. Hence A and B conclude that 60 sun miles are equal to 80 earth miles, or that the earth mile is shorter in the ratio of 3 to 4.

The earth-men, by similar observations, compare their length standard with the standard upon the sun. A^1, watching his clock

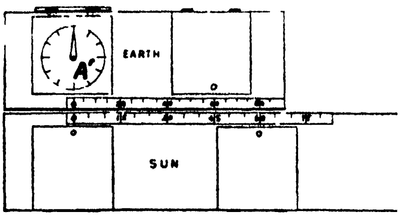

FIG. 12

(Fig. 12), finds when the hand is at 12, that zero on his scale is opposite zero on the sun scale. B^1 finds, when the hand of his clock is at 12 (Fig. 13), that 60 on his earth scale is opposite 80 on the sun scale. Hence they reason that 60 earth miles are equal to 80 sun

miles; or that the sun miles are shorter in the ratio of 3 to 4.

This apparent paradox is due to the fact that we are not accustomed to establishing simultaneity by accurate instruments of time,

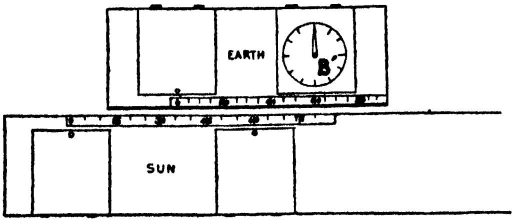

FIG. 13

but rather by a vague "now" which can be established neither by clear thought nor by experiment. We have been thinking absolute time which can not be measured, hence is meaningless; the only time that has meaning is the time we can measure with nature's instruments of time, her uniform processes.

Let us study for a moment the clocks on the moving system; to an observer outside the moving system, the two clocks will be out of synchronism; viewed from the sun (Fig. 14),

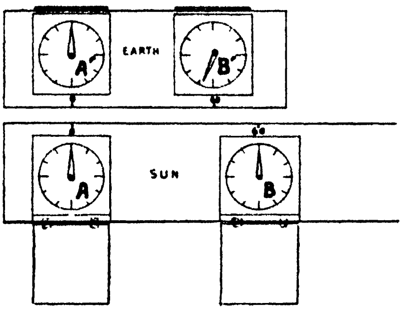

FIG. 14

B^1's clock will be five and one third hours behind the clock of A^1. If, however, A^1's clock be moved to B^1's station, it will no longer be five and one third hours ahead of B^1's clock, but will record the time of that station in perfect agreement with B^1's. In the process of moving from its own station at zero to B^1's station at 60, A^1's clock must therefore have gradually slowed up. *Vice versa,* if B^1's clock be moved to A^1's station, it will on arrival no longer be five and one third hours behind A^1's clock, but in agreement with it; in moving against the direction of the moving system it has gained five and one third hours in time.

Since the clocks are all nature's timepieces, all the clocks in one system (and we can imagine an infinite number of them) move in perfect uniformity. Each point or station on the system has its own particular local or place time (Eigenzeit). If a clock be moved from one station to another, on reaching its new station it records the place-time of that station. It would seem therefore that the impulse which sets the clock in motion in the direction of the moving system acts upon the balance wheel,—or whatever may be the clock regulator, to retard it; and the impulse which sets the clock in motion counter to the moving system acts upon the balance wheel to accelerate it.

The logical deductions that follow from these facts are so startling to the lay mind that I prefer to translate from Einstein himself:[6]

Give the watch a very large velocity (approximating the velocity of light) so that it travels with uniform speed; after it has gone a long distance give it an impulse in the opposite direction so that it returns to its starting point. We then observe that the hand of this watch during its entire journey to and fro has remained practically at a standstill, while the hand of an exactly similar watch which did not move with respect to the coordinate system (the sun or earth) has changed its position considerably.

We must add: what is true for our watch with respect to time must also be true of any other enclosed physical system, whatever its nature, because in all our thinking the watch was introduced simply as a representative of all physical actions or occurrences. Thus, for example, we could substitute for the watch a living organism enclosed in a box. Were it hurled through space like the watch, it would be possible for the organism, after a flight of whatever distance, to return to its starting point practically unchanged, while an exactly similar organism which remained motion-

[6] Zurich, *Vierteljahresschrift d. Natf. Gesell.*, 56: 1–230, 1911. Reprinted in Berlin; *Naturw. Rundshau*, 28: 285, 1912.

less at the starting point might have given place to new generations. For the organism in motion time was but a moment, if its speed approached the velocity of light. This is a necessary consequence of our fundamental assumptions and one which experience imposes on us.

Let us return to the experiment of Michelson and Morley with which we started. Let us interpret it by means of our model. We have spoken of the sun and earth in uniform translation through space; let us symbolize this by the moving system of our model, the clock at zero being the sun, and the clock at 60 representing the earth; let us send a light flash in the direction of their common translation; it starts from the sun, A^1, at 12 o'clock and reaches the earth, B^1, at 8 o'clock (Fig. 5), thus 8 units of time have elapsed. If we send the light flash against the sun and earth translation, then B^1 becomes the sun and A^1 the earth; the light flash leaves the sun, B^1, at 8 o'clock and again reaches the earth, A^1, at 4 o'clock, 8 units of time having elapsed, exactly as is the case when sun and earth are at rest (Fig. 3).

The assumptions of the principle of relativity are:

1. That among all fixed star systems not one is unique—that as far as physical phenomena are concerned it is immaterial upon what system of reference we base measurement.

2. When a light-pulse or particle travels through empty space the ratio of distance traversed to the time taken to go that distance, both measured in *any* physical system whether considered at rest or in translation, is invariant.

These two assumptions are interpretations of experimental facts, and the conclusions deduced from them as given in this paper cannot be invalidated unless these primary assumptions are shown to be misinterpretations of experiment.

To what conclusion in respect to an interstellar ether[7] does the principle of relativity lead us? That there is no place for the ether hypothesis. If the latter were correct, the ether would possess uniqueness which the first assumption of relativity denies to all bodies occupying space. Primitive man endowed our earth with uniqueness, but the Copernican controversy, though long and bitter, was final. The ether hypothesis has been very helpful to the physicist, and like a crutch to a cripple, it may yet be retained for some time to come, though mathematical analysis has deprived it of even the shadow of an existence.

The theory of relativity says that Michelson's experiment, far from being negative as Michelson thought, was exactly what was to be expected. How could an ether drift be established when the ether had no physical existence?

Relativity theorists are reconsidering Newton's suggestion as to the corpuscular structure of light and a new theory of radiation based upon the idea of quanta [discrete physical energy elements] is now being worked out in Germany and Holland. Newton's theory gave us an easy explanation of the aberration of light, discovered by Bradley, the astronomer royal of England, in 1727. He found that in order to see a star through a telescope, the latter must not be directed along the line from the eye to the star, but must be inclined in the direction of the earth's motion, just as a sportsman aims ahead of his fleeing prey. On the ether hypothesis no satisfactory explanation for aberration can be found.[8] A telescope filled with water was directed toward a star:[9] since the speed of light through water is three-fourths of the speed of light through air, a large variation in the angle of aberration was expected; but the variation found was far from what theory had predicted.

[7] H. A. Lorentz, *Physikalische Zeitschrift*, 11: 1234, 1910; Max Planck, p. 110, "Acht Vorlesungem" (Columbia Lectures, 1910); Geo. B. Pegram, *Educational Review*, 41: 290, 1911; Albert P. Carmon, *School Science and Mathematics*, 13: 1, 1913; M. Laue, *Physik. Zeitschrift*, 13: 118, 1912; Norman Campbell, *Physik. Zeitschrift*, 13: 120, 1912.

[8] H. A. Lorentz, "Electrische Erscheinungen," 1906, p. 1.

[9] Airy, *Proc. Roy. Soc. London*, 20: 35, 1871; 21: 121, 1873; *Phil. Mag.*, 43: 310, 1872.

Poincaré and Favé, Lord Rayleigh,[10] and Brace,[11] each hoped to find effects of the earth's translation through the ether in the double refraction of light by crystals, but were unable to obtain such effects. The phenomena of interference upon which Young and Fresnel based their wave theory of light have not as yet been completely accounted for upon the principle of relativity. Spectroscopists seem to prefer the use of "frequency" to "wavelength" in their descriptions of monochromatic radiation.[12] When any action forcibly ejects from an atom a light particle or an electron spinning in its atomic orbit with the speed of light, it is not difficult to perceive that the ejected light-particle would have a circular motion superimposed upon its apparent translation through interstellar space. Thus the path of a light particle would be spiral or screw-shaped, wave-length would correspond to the pitch of the screw, and frequency to the number of revolutions which the light particle makes per second. Possibly a theory of interference may be worked out along this line.

The new mechanics teaches that the velocity of light, 186,337 miles per second, is our limit of speed; no body in motion can exceed it, and can only with extreme difficulty approach it.

The old mechanics taught that a constant force continually acting upon a body in interstellar space, would make it go faster and faster without limit. The principle of relativity says that a constant force acting upon a body during successive intervals of time meets a greater and greater opposition to its increasing speed; and when it has attained the speed of light the power of this force to produce acceleration is exhausted. There is nothing, of course, in empty interstellar space to prevent a body from continuing forever with the speed once acquired, except collision with another heavenly body, when perchance, the energy of motion changes the cold colliding matter into a radiant sun.

[10] Rayleigh, *Phil. Mag.*, 4: 683, 1902.

[11] Brace, *Phil. Mag.*, 7: 328, 1904.

[12] Runge, *Zeitschrift f. Electrochemie*, 18: 485, 1912.

The old mechanics was quite sufficient until the discovery of cathode rays and radium gave us matter in motion outspeeding a thousand times our fastest planet, Mercury. The particles in the stream of cathode rays travel with a velocity of 5,000 miles a second, while those from radium are hurled into space with a speed of 50,000 to 178,000[13] miles per second, and have become in many instances the modern surgeon's scalpel. The physicist, in his search for law with respect to matter, finds it necessary to readapt his mechanics to modern facts.

The question naturally arises: why should the speed of light be set as a limit to the increase of velocity? The answer is that with unlimited speed the possibility arises of a reversal in the order of time. This possibility has been worked out in a curious way by Flammarion.[14] He makes Lumen, an interstellar traveler, an observer of the battle of Waterloo, and then proceeds to show what would happen if, at the close of the battle, he were moving away from the scene with a velocity greater than the speed of light; he would overtake the light which left the battlefield at the beginning of the engagement, and would see the whole fray in a reversed order of time, like a moving picture film run off backward.

Secondly, if Lumen were at rest and the earth were speeding away from him with a velocity greater than that of light, he would see the battle in its natural order, but all would proceed with stately slowness.

Thirdly, if Lumen were at rest and the earth were speeding toward him with a velocity greater than the speed of light, he would again see the battle in the reverse order, as the last fire from the guns would come to Lumen from a point nearer to him than the light from the first volley.

With any experiment thus repeated three times, Lumen would be able to determine whether he were at rest and the earth in motion, or *vice versa;* in other words, he would

[13] Rutherford, *Physikalische Zeitschrift*, 13: 1178, 1912.

[14] C. Flammarion, "Stories of Infinity—Lumen," p. 74, 1873.

be able to establish absolute motion, a contradiction of the first assumption of the principle of relativity.

Hence in all physical problems where there is a possibility of two solutions, the one which leads to the establishment of an absolute velocity must be rejected, and the alternative solution accepted as valid.

The principle of relativity, besides clearing our minds of the cobwebs of absolute time and space, gives us, through its explanation of physical experiments, a deeper consciousness of the manifoldness of space, in which time is, not the flow of duration suggested by the immortal Newton, but any one of the spacial manifolds so beautifully developed by Heinrich Minkowski in his "Raum und Zeit," and by Wilson and Lewis in the *Proceedings of the American Academy* for 1912.

REINHARD A. WETZEL
THE COLLEGE OF THE CITY OF NEW YORK

GRANTS BY THE BRITISH ASSOCIATION

AT the Birmingham meeting of the British Association for the Advancement of Science grants in aid of scientific research amounting to about $6,000 were made as follows:

Mathematical and Physical Science: Professor H. H. Turner, seismological observations, £60; Dr. W. N. Shaw, upper atmosphere, £25; Sir W. Ramsay, constants and numerical data, £40; Professor M. J. M. Hill, calculation of mathematical tables, £20; Lieut.-Col. A. Cunningham, copies of the "Binary Canon" for presentation, £5.

Chemistry: Dr. W. H. Perkin, study of hydroaromatic substances, £15; Professor H. E. Armstrong, dynamic isomerism, £25; Professor F. S. Kipping, transformation of aromatic nitroamines, £15; A. D. Hall, plant enzymes, £25; Professor W. J. Pope, correlation of crystalline form with molecular structure, £25; Professor H. E. Armstrong, solubility phenomena, £15.

Geology: R. H. Tiddeman, erratic blocks, £5; Professor P. F. Kendall, list of characteristic fossils, £5; Dr. A. Strahan, Ramsay Island, Pembroke, £10; Professor Grenville Cole, old red sandstone of Kiltorcan, £10; G. Barrow, trias of western midlands, £10; Professor W. W. Watts, sections in Lower Paleozoic rocks, £15.

Zoology: Dr. A. E. Shipley, Belmullet Whaling Station, £20; Dr. Chalmers Mitchell, nomenclator animalium, £50; S. F. Harmer, Antarctic whaling industry, £90.

Geography: Professor J. L. Myres, maps for school and university use, £40; Professor H. N. Dickson, tidal currents in Moray and adjacent firths, £40.

Engineering: Sir W. H. Preece, gaseous explosions, £50; Professor J. Perry, stress distributions, £50.

Anthropology: Dr. R. Munro, Glastonbury Lake Village, £20; Sir C. H. Read, age of stone circles, £20; Dr. R. Munro, artificial islands in Highland lochs, £5; Professor G. Elliot Smith, physical character of ancient Egyptians, £34; Professor J. L. Myres, anthropometric investigations in Cyprus, £50; Professor W. Ridgeway, Roman sites in Britain, £20; Dr. R. R. Marett, Paleolithic site in Jersey, £50.

Physiology: Professor E. A. Schäfer, the ductless glands, £35; Professor A. D. Waller, anesthetics, £20; Professor J. S. Macdonald, calorimetric observations, £40; Professor C. S. Sherrington, mammalian heart, £30.

Botany: Professor F. J. Oliver, structure of fossil plants, £15; Professor A. C. Seward, Jurassic flora of Yorkshire, £5; Professor F. Keeble, flora of peat of Kennet Valley, £15; A. G. Tansley, vegetation of Ditchan Park, £20; Professor F. F. Blackman, physiology of heredity, £30; Professor F. O. Bower, renting of Cinchona Botanic Station in Jamaica, £25; Professor W. Bateson, breeding experiments with *Œnotheras*, £20.

Education: Professor J. J. Findlay, mental and physical factors, £30; Dr. G. A. Auden, influence of school books on eye-sight, £15; Sir H. Miers, number, etc., of scholarships, held by university students, £5; Dr. C. S. Myers, binocular combination of kinematograph pictures, £10; Professor J. A. Green, character and maintenance of museums, £10.

SCIENTIFIC NOTES AND NEWS

THE British Association for the Advancement of Science has accepted an invitation to hold the meeting of 1915 at Manchester. It will be remembered that next year's meeting will be held in Australia under the presidency of Dr. William Bateson.

THERE have been called to the Research Institute for Biology, established under the

Kaiser Wilhelm Society, Dr. Goldschmidt, of Munich, known for his experiments on Mendelian heredity in animals; Dr. Hartmann, of the Berlin Institute for Infectious Diseases, known for his work on protozoa, and Dr. Warburg, son of the director of the Reichsanstalt, who will have charge of work on cell physiology. It was noted last week that Dr. Carl Correns will be director of the institute.

Dr. David Hilbert and Dr. Felix Klein, professors of mathematics at Göttingen, have been elected corresponding members of the Berlin Academy of Sciences.

Dr. Max Planck, professor of mathematics, has been elected rector of the University of Berlin.

Countess Proskowia Uwarow, of Moscow, known for her work in archeology, has been given an honorary doctorate by the University of Königsberg.

Dr. Wilhelm Alexander Freund, the distinguished German gynecologist, has celebrated his eightieth birthday.

M. Emil Boutroux, of Paris, and Professor Alois Riehl, of Berlin, both distinguished for their contributions to philosophy, will make addresses at the opening of the graduate school of Princeton University.

Dr. W. F. G. Swann, demonstrator in physics in the University of Sheffield, has been appointed physicist in the laboratory of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington.

Professor C. W. Thompson, chief of the bureau of research in agricultural economics at the University of Minnesota, has taken charge of work in the rural organization service of the U. S. Department of Agriculture.

Dr. Henry Carter Adams, professor of political economy at the University of Michigan, has accepted the post of general fiscal adviser to the Republic of China.

Major B. K. Ashford has been appointed president of a board for the study of tropical diseases in Porto Rico under the medical department of the army.

The *Annalen der Naturphilosophie* will hereafter be named the *Annalen der Natur- und Kulturphilosophie*. Professor R. Goldscheid will be associated with Professor Ostwald in editing the periodical.

At Princeton University Professor Henry B. Fine has returned from a year's leave of absence in Europe and resumed his duties as head of the department of mathematics and dean of the department of science. Professor George A. Hulett, who was last year acting as chief of the department of chemistry in the United States Bureau of Mines, has resumed his professorship of physical chemistry. The members of the faculty on leave of absence this year include: Professor Norman Kemp Smith, head of the department of philosophy (first term); Professor Augustus Trowbridge, of the department of physics, and Professor Oswald Veblen, of the department of mathematics.

Professor M. A. Carleton, cerealist of the U. S. Department of Agriculture, has recently resumed his duties in that department, after a year and three months' leave of absence as general manager of the Pennsylvania Chestnut Tree Blight Commission.

Professor A. E. Kennelly, of Harvard University, represented the U. S. Committee and the U. S. Bureau of Standards at the International Illumination Commission in Berlin, August 26–30, and at the International Electrotechnical Commission, Berlin, September 1–5.

Professor Augustus D. Waller, M.D., F.R.S., of the University of London, will lecture before the Harvey Society at the New York Academy of Medicine, at 8.30 P.M., October 4, 1913, on "A Short Account of the Origin and Scope of Electrocardiography." Professor Waller brings from London his own apparatus especially for this lecture and will give a series of demonstrations. The lecture is open to the public.

A course of three lectures dealing with the early history of medicine will be given before the Royal Society of Medicine, London. The first lecture will be on October 10, by Professor

Morris Jastrow, of the University of Pennsylvania, and will treat of Babylonian medicine; the subsequent lectures will be by Professor Elliot Smith, on Egyptian medicine, and by Professor R. Caton, on Greek medicine.

PROFESSOR VON BAELZ, for thirty years professor of medicine in the University of Tokyo, the author of contributions to medicine and anthropology, has died at Stuttgart, aged sixty-four years.

PROFESSOR JOHN ROBIE EASTMAN, professor of mathematics in the navy from 1865 to 1898, when he was retired for age, died on September 26, at the age of seventy-seven years. In 1906 Professor Eastman was promoted to the rank of rear admiral in the navy. He had made distinguished contributions to solar, stellar and meteoric and planetary astronomy.

DR. JOHN GREEN CURTIS, from 1876 to 1909 professor of physiology in the College of Physicians and Surgeons, Columbia University, and since emeritus professor, died on September 20, aged sixty-nine years.

DR. CHARLES LESTER LEONARD, professor of roentgenology in the University of Pennsylvania, died on September 23, aged fifty-two years, from X-ray dermatitis, contracted in the course of his work nine years ago.

DR. ARNOLD ROSSEL, formerly professor of chemistry at Bern, has died at the age of sixty-eight years.

PROFESSOR PAUL ADOLF NÄCKE, director of the insane asylum at Colditz, known for his contributions to psychiatry, has died at the age of sixty-three years.

THE death is also announced of Dr. Georg Roth, emeritus professor of mathematics at Strassburg.

THE Washington Biologists Field Club has passed the following resolution:

In the death of Edward Lyman Morris, one of the founders of the Washington Biologists Field Club, on September 14, 1913, at Brooklyn, N. Y., this association has lost a member whose deep interest in its affairs never failed from the first days of organization to the last moments of his life. Although duty called him to another city, he never lost an opportunity to advance the interests of the club, and on the week preceding his death he spent three days at his beloved island and recorded on the register the flowering of a rare plant.

The members of this club mourn the loss of an ardent worker, a congenial companion, a respected associate and friend.

Resolved, that the Washington Biologists Field Club extend to the family of our deceased member its sincerest sympathy and condolence.

For the Club,
E. A. SCHWARZ,
A. K. FISHER,
H. C. FULLER

THE U. S. Civil Service Commission announces an examination for associate physicist in theoretical and experimental optical research to fill a vacancy in this position in the bureau of standards, Department of Commerce, Washington, D. C., at a salary of $2.500 a year.

EXAMINATIONS will also be held for quarry technologist to fill a vacancy in the Bureau of Mines at Washington, D. C., at a salary ranging from $2,500 to $3,000, and for junior physicist in the Bureau of Mines, Pittsburgh, Pa., and other places as they may occur, at a salary ranging from $1,020 to $1,200 a year.

THE seventh annual convention of the National Society for the Promotion of Industrial Education and the organization meeting of the National Educational Guidance Association will be held at Grand Rapids, Mich., from October 19 to 25.

THE annual meeting of the American Institute of Chemical Engineers will be held in New York from December 10 to 13.

UNDER the auspices of the school of mines at Berlin, there are offered prizes amounting to 2,000 marks for promoting safety in mines.

ARRANGEMENTS are being made for an expedition to King Edward the Seventh's Land, a tract stretching from the Great Ice Barrier, to start in August next year. It will be under the command of Mr. J. Foster Stackhouse, who was intimately associated with Captain Scott in organizing the voyage of the *Terra Nova.* It is proposed that the members of the expedi-

tion sail from the Thames about the middle of August, 1914, in the steam yacht *Polaris,* a ship especially built in Norway for ice navigation in accordance with designs approved by an international committee of explorers, including Charcot, de Gerlache and Nansen. The expedition will, it is expected, be away for 20 months or more.

Mr. Truman H. Aldrich, of Birmingham, Ala., has presented to the Museum of the Geological Survey of Alabama his entire conchological collection, by estimate about 20,000 species from all parts of the world. In addition to his own extensive gatherings and exchanges during more than 50 years, Mr. Aldrich had purchased largely not only from dealers but from such special workers as Garrett and Doherty. He had bought outright several important private collections, notably the entire Mauritius gatherings of the late Col. Nicholas Pike, the Jones Bermuda and Nova Scotia Shells, and the Parker cabinet of about 5,500 listed species. The Aldrich collection is particularly rich in Asiatic and Indian forms. The series of operculate land shells could hardly be matched in this country, and there are many types of species described by Mr. Aldrich and others. With the shells were given 1,300 or more volumes of conchological and other scientific works. Mr. Aldrich had already given all his duplicates, probably 200,000 specimens, to the museum, and last year he donated a very large and fine series of Tertiary invertebrate fossils. The museum, it may be noted, moved into its new building, Smith Hall, less than four years ago. Though the outcome of the Geological Survey and bearing its name, it is by law an integral part of the University of Alabama. Dr. Eugene A. Smith, since 1873 at the head of the survey, is also director of the museum.

Dr. W. A. Sawyer, director of the hygienic laboratory of the California State Board of Health, and W. B. Herms, assistant professor of parasitology in the University of California, have contributed to the *Journal* of the American Medical Association an article in which they reach the following conclusions: (1) In a series of seven experiments in which the conditions were varied, we were unable to transmit poliomyelitis from monkey to monkey through the agency of the stable-fly. (2) Further experimentation may reveal conditions under which the stable-fly can readily transfer poliomyelitis, but the negative results of our work and of the second set of experiments of Anderson and Frost lead us to doubt that the fly is the usual agent in spreading the disease in nature. (3) On the basis of the evidence now at hand we should continue to isolate persons sick with poliomyelitis or convalescent, and we should attempt to limit the formation of human carriers and to detect and control them. Screening of sick-rooms against the stable-fly and other flying insects is a precaution which should be added to those directed against contact infection, but not substituted for them. (4) The measures used in suppressing the house-fly are not applicable to the control of the stable-fly owing to its different breeding habits and food-supply. Methods should be devised for diminishing the numbers of stable-flies, as they are a great annoyance to cattle and, in all probability, are capable of transferring and inoculating a number of the diseases of animals.

The birth of ten calves in the buffalo herd maintained by the government on the Wichita national forest and game refuge, near Lawton, Oklahoma, has been reported by the game warden in charge. The herd now contains a total of 48 head of full-blooded buffalo, or, more properly, bison, of which 27 are males and 21 females. All of the animals are in good condition. In 1907 the American Bison Society donated to the federal government a nucleus herd of 15 animals which had been bred and reared in the New York Zoological Park. The animals were transported to the Wichita national forest, which is also a game refuge, and placed under the care of the Forest Service. They readily adapted themselves to their new habitat, but the area upon which they were placed was within the zone affected by the Texas fever tick and during the two or three years following their transfer only the constant care and watchfulness of the forest

officers prevented the complete loss of the herd. The animals were examined almost daily to determine whether they had become infested with Texas fever ticks and were placed in specially designed cages and sprayed with crude oil at intervals of from fifteen to thirty days, but notwithstanding the extreme precautions which were adopted, three of the animals died. Gradually, however, the enclosures in which the buffalo were confined were freed from fever ticks and there is a possibility that as the buffalo adapted themselves to their new environment they became more or less immune to the disease. No losses from Texas fever have occurred for several years, and the herd has almost quadrupled in number since it was established. The fact that the herd has not increased more rapidly is due largely to the preponderance of male calves. This characteristic of the buffalo is so pronounced in all of the herds now in captivity that a cow is considered twice as valuable as a bull.

UNIVERSITY AND EDUCATIONAL NEWS

Ernest Solvay, the discoverer of a process for the manufacture of soda, celebrated the fiftieth anniversary of that discovery on September 2 at Brussels by giving more than $1,000,000 to educational and charitable institutions and the employees of his firm. The Universities of Paris and Nancy each received $100,000.

At the last session of the Legislature of Pennsylvania an appropriation of $40,000 was made to aid in the development of courses in education at the University of Pennsylvania. Dr. Frank P. Graves, of the Ohio State University, has been appointed professor of the history of education, and Dr. Harlan Updegraff, of the Iowa State University, as professor of educational administration. Professor A. Duncan Yocum, who now occupies the chair of pedagogy at the University of Pennsylvania, will continue as professor of educational research and practise.

A graduate school of education has been established at Bryn Mawr College. It is under the charge of Professor Kate Gordon, associate professor of education, Dr. Matilde Castro, director of the Model School, and Professor James H. Leuba, professor of psychology, who will give a graduate course on the psychology of defective and unusual children.

The University of California has announced the establishment of a new Division of Rural Institutions. This new department will study and aid the rural forces which have for their aim the making of life in the open country successful and satisfactory. Elwood Mead has been called to the headship of this new division. He was formerly chief of the United States Bureau of Irrigation Investigations. He is now in Australia, as chairman of the Rivers and Water Supply Commission of the State of Victoria and chief engineer. His work in the University of California will be to deal with questions of farm credits, irrigation and drainage institutions, cooperation, and all the varied political, economic, educational, social and religious institutions which affect rural life.

Work has been begun at Smith College on the erection of a new biological laboratory which is to cost $150,000.

Professor Don Rosco Joseph, of Bryn Mawr College, has accepted a call to the medical school in St. Louis. His work in physiology at Bryn Mawr College will be given by Professor Arthur Russell Moore, now assistant professor in the University of California.

Dr. Paul S. McKibben has left the department of anatomy of the University of Chicago to become professor of anatomy in the Western University of London, Ontario.

Dr. G. E. Coghill, of Denison University, has been appointed associate professor of anatomy at the University of Kansas, Lawrence.

Edmund Vincent Cowdry, associate in anatomy of the University of Chicago, goes this fall to the Johns Hopkins Medical School.

Dr. Clara Moore, pathologist in the North Chicago Hospital, has been appointed instructor in clinical medicine and diagnosis in the University of Wisconsin.

DR. HENRY E. RADASCH, assistant professor of histology and embryology at Jefferson Medical College, has been appointed instructor of anatomy in the Pennsylvania Academy of Fine Arts to succeed the late Dr. George B. McClellan.

DR. C. C. LIPP, assistant professor of veterinary science at the University of Minnesota, has been elected head of the department of veterinary science of the South Dakota Agricultural College.

AT Norwich University Dr. S. F. Howard, formerly associate professor at Amherst College, is to be head of the chemistry department. J. E. Lear, B.S., formerly associate professor in the Texas College, Texas, has been appointed assistant professor of physics and mathematics.

AT the University of Pennsylvania Dr. Thomas D. Cope and Dr. E. A. Eckhardt have been promoted to assistant professorships in physics; Dr. Walter T. Taggart to the grade of professor of organic chemistry; Dr. Owen L. Shinn to be professor of applied chemistry, and Dr. Herman C. Berry to be professor of materials of construction.

HARRY WALDO NORRIS, A.M., professor of zoology at Grinnell College, has been appointed to give instruction in zoology in Harvard University during the year 1913–14, in accordance with the agreement with western colleges. His term of service will fall in the second half-year.

DR. M. BARTUZZI has been appointed to a newly established chair of medical history in the University of Siena.

DISCUSSION AND CORRESPONDENCE

THE BREAD SUPPLY

IN SCIENCE of August 22, 1913, appear twenty columns of words from Professor H. L. Bolley, entitled "Cereal Cropping: Sanitation, a New Basis for Crop Rotation, Manuring, Tillage and Seed Selection." Under this imposing and comprehensive title we find that eighteen columns are devoted chiefly to belittling the work of chemists, agronomists, bacteriologists, and also agricultural advisers who accept the findings of such scientists. Occasionally Professor Bolley hedges with the assertion that he knows plant food to be essential, and then renews the attack in such words as these:

> On account of all these conditions of low yield and invariable deficiency in quality, there has gone up a great cry of "depleted" soils, "worn out" land, "bad agriculture," "shiftless methods," etc. This cry follows the plowman regardless of his improved tools and general farming improvements, regardless of better methods of tillage which we know now obtain on the farm, as against those which our forefathers were able to accomplish, and all regardless of hard work. It is all right for the banker and the lawyer, and even some professors, to berate the farmer for idleness and inefficiency in methods and lack of business, but I say let such men try to raise wheat of high grade under the present general understanding as laid down in books, or by our best agriculturists. In spite of all these directions, the wheat soon becomes soft and shows all of the peculiar characteristics which we find named in the literature of the chemical laboratory, or in the milling tests of wheat as previously indicated, "white-bellied," "piebald," or shrivelled, bleached and blistered, "black-pointed," in fact all of the qualities of deteriorated grain; and the chemist from his laboratory outlook cries out "depleted soils," "lost fertility," "bad physical texture," due to "worn-out humus," "lost nitrogen," "insufficient phosphates," "lime," etc., forgetting, as it were, that almost every field in these matters is a law unto itself and that every one of these fields in the next few years may contradict all these assertions by the growth of splendid crops for reasons no one seems to know. The expert agriculturist and agronomist, who take their cue largely from the chemists, cry out: "Give us intensified agriculture," "Apply phosphates," "Apply lime," "Apply potash," "Grow clover," "Raise corn," "Rotate," all in a confused jumble, and lately the bankers, afraid of their mortgages, have become very busy and tell how to farm and scold rather strongly about lack of business methods on the farm, berate the schools, etc.
>
> These conditions of farm cropping, though not exclusively American, are especially in prominence at present because many of our most noted publicists are becoming, perhaps properly, alarmed. They say our farmers show no ability of maintaining the supply of wheat, the bread grain, a

permanent cropping element of old land agriculture, but rather, instead, are reaping lessened yields of poorer quality from larger acreages.

In columns one and twenty the "new basis" is revealed:

> Deteriorated wheat, as seen in depressed yields and low quality, as now quite commonly produced in the great natural wheat-producing regions of this country, is not, primarily, a matter of lost fertility or of modified chemical content of the soil, but is specifically a problem of infectious disease which is superimposed upon the problems of soil and crop management.
>
> My experience with cereal crops with reference to the application of fertilizers, the trial of varieties, experiments in seed selection, seed breeding and seed treatment, and seed purification furnish data which will allow me to say that I have no fear that all will eventually agree that sanitary considerations with reference to the characteristics of parasitic diseases which are now quite commonly resident in the seed and the soil will yet form the essential basis for the proper management of crops in rotation in series, and the same considerations will largely govern the type of tillage and the manner of handling waste materials on the farm, particularly farm manures.

Professor Bolley heartily commends himself for "having grown up on the farm, and never having allowed himself to get away from the real love of working in the dirt"; but he fears that "too many of our workers who are paid to investigate agricultural problems may only investigate for their own enjoyment—may again deal in formulas, and theories, books and philosophies, and thus give out to the working public fine philosophies which may yet leave the worker helplessly in the dark as to what to do."

As an average of sixty years where wheat has been grown year after year on the same land at Rothamsted, the unfertilized land produced 12.6 bushels per acre, while 35.4 and 37.0 bushels were the respective yields where farm manure and commercial plant food were applied.

As an average of twenty-four years the wheat yields at Pennsylvania State College varied from 10.1 bushels on unfertilized land to 24.1 with farm manure and 24.8 with commercial plant food, when grown in a four-year rotation.

As an average of nineteen years the wheat yields at the Ohio Experiment Station were 10.2 bushels on unfertilized land, 21.7 bushels with farm manure, and 26.9 bushels where commercial plant food was applied, the wheat being grown in a five-year rotation with clover, timothy, corn and oats, on five different series of plots, so that every crop might be represented every year.

As compared with Rothamsted, Pennsylvania and Ohio, the more extensive and very practical field experiments now being conducted by the University of Illinois in many different parts of the state are new and inconclusive, but the results secured in 1913 from fields that have been in operation twelve years (see the accompanying tabular statement) not only represent much field work, but they also support the equally valuable analytical data from the chemical laboratory involving analyses of thousands of representative soil samples collected in connection with the detail soil survey of more than forty counties.

1913 Wheat Yields: Bushels per Acre
From University of Illinois Experiment Fields

Location of Experiment Field	Number of Years in Crop Rotation	Soil Fertilization				
		None	Organic Manures	Organic Manures, Limestone	Organic Manures, Limestone, Phosphorus	Organic Manures, Limestone, Phosphorus, Potassium
Urbana....	Four	11.1	13.6	19.7	34.6	31.7
Odin........	Four	17.3	20.4	29.8	36.0	37.0
DuBois.....	Four	7.2	no test	18.1	33.4	29.9
Cutler.......	Three	8.8	7.0	19.5	31.0	30.7
Mascoutah	Four	21.0	22.1	24.0	32.9	32.3
General average...		13.1	—	22.2	33.6	32.3
Average increase..		—	—	9.1	20.5	19.2

The unfertilized surface soil of these fields contains in two million pounds (corresponding to an acre of land about $6\frac{2}{3}$ inches deep) from 700 to 1,200 pounds of total phosphorus and from 25,000 to 36,000 pounds of total potassium. Where organic manures are pro-

vided for supplying nitrogen and liberating mineral plant food in rational systems of farming, the relationship between the chemical composition of the soil and crop production is normally very apparent. Irrational systems often give abnormal results, and their correct interpretation requires that no important factor of influence shall be ignored.

It may be added that the wheat from our well-treated and high-yielding plots is not of poor quality, but of very high grade, and has been sold to the experienced grain buyer at a premium as high as 15 cents per bushel above that paid for wheat from unfertilized well-rotated land.

In Illinois, as in all other states, most of the soil and crop investigators are men of large practical farm experience, but we also have deep respect for the science of analytical chemistry, as the only means of determining the total stock of plant food in the soil, and for the science of biochemistry, as the chief means of making plant food available.

Chemists and agronomists must honor Jensen for the information and method which he gave to the world relating to the destruction of fungous diseases sometimes carried in seed grain, and we honor Bolley for his valuable contributions in this field of agricultural research; but we also recognize that the avoidance of fungous diseases as one among the many advantages and reasons for crop rotation and for the proper handling of crop residues is not a new idea, for it has been advanced, explained and emphasized by numerous investigators for many years. The persistent efforts to belittle the importance of positive soil enrichment and preservation in permanent rational systems of farming, whether by improvident landowners, by Whitney and Cameron, of the Bureau of Soils, or by Professor Bolley, are the greatest curse to American agriculture and the greatest danger to permanent prosperity in this country.

The fact that the earth is round became generally accepted two or three centuries after its discovery; and it required a full century for Europe to half appreciate the great discovery by De Saussure, so well expressed in the words of Liebig:

> It is not the land itself that constitutes the farmer's wealth, but it is in the constituents of the soil, which serve for the nutrition of plants, that this wealth truly consists.

The foundation principles for the restoration and preservation of the fertility and productive power of normal soils are simple and well-established, and no state in the union can afford to ignore or belittle these great fundamental truths, nor to have the minds of its farmers and landowners befogged in relation thereto.

Cyril G. Hopkins

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SCIENTIFIC BOOKS

The Living Plant. By William F. Ganong. New York, Henry Holt and Co. 1913. 17 × 23 cm. Pages xii + 478; 3 colored plates; 178 figures, many in text. Price, $3.50.

This book aims to attract popular interest and at the same time to tell the truth about its subject. The work is avowedly not intended for scientists, but "it seeks to present to all who have interest to learn an accurate and vivid conception of the principal things in plant life" (preface). Thus the author has "been at more pains to be clear than to be brief," and the book "has wandered through a leisurely course to a length quite shockingly great" (preface). Nevertheless, the depth in natural science to which the reader is here carried is so great as to make it probable that the book will find its greatest use among those who already possess considerable knowledge of plants and their processes.

The style of the book combines clearness with personal frankness, the reader being taken into the author's confidence from the very first; it is a conversational style of the highest type, becoming even chatty at points, and generally maintaining a logical clearness and definiteness that is rare in popular or even elementary treatises upon such complex subjects. The language possesses a characteristic quaintness, almost an archaic tang at some points. A few examples of quite col-

loquial or even slang expressions may be noted. Regarding the numerous illustrations, they are exceedingly well chosen and well prepared, and they add markedly to the clearness of the exposition.

The author's attitude is conservative and many questions are left just as they should be, in a quite undecided condition. At the same time, the reader is admitted to some of the pleasures of hypothesis-making and of prophecy, generally in a very safe and clearly guarded manner, for the author has not hesitated to enliven his story and perhaps accelerate the advance of his science, by indulging in suggestions of scientific possibilities and probabilities.

"A table designed to display the plan of this book" is inserted after the table of contents, and exhibits a sort of synoptical outline of the subjects considered in the eighteen chapters, together with their logical connections. It is seldom that a book of this sort brings out as clearly as does the one before us the important relations of its various topics to each other and to human activities in general. Diagrams and tables are frequently resorted to. After a chapter on the ways in which plants appeal to human interest, seven chapters treat the material and energy transformations in the plant body. Then follows a chapter on irritability, one on "protection," two on reproduction, and two on growth. The four remaining chapters consider respectively, dissemination, evolution and adaptation, plant breeding and classification. This obviously very broad treatment comprises a sufficiency of new methods of presentation and novel placings of emphasis to make the book profitable reading for the research worker and the teacher as well as for the less advanced student.

Turning now to fault-finding, a few adverse criticisms may be noted as to use of words. The word *mani-colored* occurs in several places (*e. g.*, page 261); does not such a novelty suggest *handpainted?* Insectivorous plants are termed *insectivora* (page 104, for example); if the Latin form is employed we should prefer not to apply the neuter form to plants (*plantæ*). In these decadent days, as far as general interest in the ancient foundations of our language is concerned, it were perhaps better to cling to the perfectly safe but less euphonious English form, insectivores. The word *plenty* appears to be used throughout (*e. g.*, pages 140, 266) as a predicate adjective, where ordinary usage requires plentiful, plenteous or a word with some other root. To most scientists, and perhaps to most readers, these points may seem of little import, but the very excellence of the diction which characterizes this book as a whole renders its few shortcomings of this sort all the more outstanding.

As to the scientific matter itself, probably the only quite inadequate exposition occurs in connection with the discussion of capillarity (pages 180, 181), which, as it stands, seems to the reviewer logically quite hopeless. It is to be regretted that the author surrendered here to the suasion from his critic and forbore "to explain this interesting process in detail to the reader" (page 179).

All will agree with Professor Ganong, that any truthful chapter on protoplasm must "leave you with a very unsatisfied feeling" (page 164), but it does seem that the conception of this material might be clarified by the omission of the idea of "protoplasm *par excellence*" (page 143), letting the mixture of many substances stand for the present as the seat of the numerous, more or less peculiar processes which taken together make up life. If it pleases one's fancy to think that vitality is possessed by some single substance in protoplasm and that all other contained substances are to it merely environmental or conditional, no one can assert that such a view is illogical; this is purely a matter of feeling, over which we do not argue. But none can agree with the author, that "we are logically bound to believe that some such substance [as protoplasm *par excellence*] must exist as the seat of the distinctive properties of life" (page 143). Some people may be bound to believe this, but they are assuredly not *logically* so bound; nothing is now known of protoplasm which forces such an issue.

Likewise, it is difficult to find grounds for agreeing with the author when he states (page 199) that transpiration is a process "for which there is no equivalent in animals." Excepting when the higher animal is covered with water there is always more or less cuticular transpiration from its skin, just as there is in plants, and the wet membranes of the lungs and air passages are always transpiring large amounts of water into the internal atmosphere, just as happens in plant foliage and the like. Transpiration is a phenomenon common to all living things which are exposed to air, though its indirect effects are of course different in different forms.

A method of exposition to which many botanists will probably object, but which will no doubt receive the hearty approval of most physiologists, is the presentation of the entire subject of sexual reproduction without reference to the alternation of generations. From the dynamic point of view, it is surely desirable for an elementary treatise thus to omit the complicated story of sporophyte and gametophyte, megaspores and microspores. The reviewer looks upon this as a real stroke of genius, considering the dominance of these things in present-day botany.

Last, but not by any means least, among the points selected for mention here, is what may be termed the philosophy of the book before us. The whole presentation is frankly and insistently permeated with the peculiar confusion, so common in biological reasoning, of causes with effects; the account is written from the teleological standpoint. The author adds a new deity to the growing biological pantheon, thus developing "a perfectly natural vitalism based on the superior interpretative power of a hypothesis assuming the existence in nature of an X-entity, additional to matter and energy but of the same cosmic rank as they, and manifesting itself to our senses only through its power to keep a certain quantity of matter and energy in the continuous orderly ferment we call life" (page viii). To the purposefulness of this unknown Something are attributed the determining conditions that bring about the more complex phenomena of living things; wherever the physical antecedents or determining conditions of a phenomenon are not known (and they are mostly unknown in physiology), the hypothesis of the X-entity supplies a word with which to cloak our ignorance—as Professor Barnes used to say—and in this seems to lie the "superior interpretive power" of such hypotheses.

But this is not the place to add to the already great and bemuddled mass of academic argument concerning this present-day survival of the doctrine of special creation. Space may be taken to note further only three interesting aspects of the general philosophical attitude of "The Living Plant." First, non-teleologists will welcome the frankness and clearness with which the position of the author has been stated. While many teleologists explain the prevalent use of purposeful implications merely as verbal short-cuts, disavowing all belief in what the words actually state, and while such vague mental positions seem to give some weight to the accusation that it is but a "man of straw" against which the scientific monist directs his javelin, our present author makes it perfectly and unmistakably clear that he does hold to purpose as a logical cause of phenomena in matter and energy. Such clear statements must do much to clarify the atmosphere of this seemingly everlasting discussion.

The second interesting philosophical feature requiring some attention here is this, that along with the *deus ex machina* postulated to guide the threads through the active loom of time, and along with the common, every-day forces of the physical sciences, which seem to be conceived as keeping the loom in operation, there seems also to be (though the author does not definitely bring this out) a third force, or at least a third kind of factor, which takes part in conditioning phenomena, namely, *accident* or *chance*. One comes away from a careful reading of the entire presentation with a feeling that vital phenomena are brought about through the interaction of these three groups of directing conditions, the X-entity, nature and chance. No doubt the author will

agree, however, that chance is nothing but the very thing which emerges to some of us in his X-entity, just some complex of conditioning factors not yet known.

Finally, the book before us is pedagogically nearly ideal, and it may be that its teleological philosophy is one of its strong points in this regard. As the author will assuredly agree, scientific research is one thing and the teaching of science quite another; the elementary teacher does not try to tell the whole truth, but only those portions which may best lead on to such a state of mind in the student as will some time, perhaps, enable him to understand a large portion of the truth. Now, considering that physical causation is far too complex a subject even to be thought about adequately, until the thinking person has accumulated a vast store of accurate scientific experience, it may well follow that a perfectly monistic philosophy would not serve at all in an elementary treatise, and that a somewhat *devitalized* dualism is the only sort of inclined plane by which the scientifically untrained mind may be led toward the highest and clearest altitudes of scientific philosophy.

In conclusion, the book we have been considering is one of the American Nature Series, is bound in green cloth with a gilt-ornamental back, and is about 4 centimeters thick. It will always be read lying on the table. The paper stock is very heavy, clay-coated and highly surfaced, so that the numerous half-tone illustrations are exceedingly satisfactory. It is, however, also true that the position of the book and reader must be properly chosen to avoid dazzling high lights where the midnight lamp is reflected in the mirror-like surface of the paper. As with all such coated papers, a distinct odor of glue is perceptible throughout the reading; spattered water will play havoc with the pages.

B. E. Livingston

Studies in Luminescence. By Edw. L. Nichols and Ernest Merritt. Published by the Carnegie Institution of Washington, 1912. Royal 8vo, vi + 225 pp.

The memoir represents the results of investigation extending over a period of nine years. In large part it gives the experimental observations made by the authors; but in it are also observations on one or another phase of the general subject, made by other observers, mainly, however, under the guidance of the authors. The work has been aided by occasional grants of money from the Carnegie Institution of Washington, and the memoir is published by the institution. The material has been published previously in separate articles, most of which have appeared in the *Physical Review;* but it has now been given such continuity of form and (in the last two chapters of the memoir) such valuable theoretical discussion as to make the present publication one of unusual interest and value.

The authors, during these years, have evidently kept steadily before themselves the intention of using the spectrophotometer to the farthest possible extent. The success with which they have held to such intention, in investigations of a dozen or so of luminescent substances, is nothing short of remarkable. Measurements of intensities have been carried out far toward the edges of fluorescent and phosphorescent bands. In the cases of nearly all substances investigated, measurements were made to determine the exact form and extent of absorption bands corresponding to given luminescence bands. The dependence of the intensities of luminescence upon the wave-length of exciting light, and the distribution of intensities for some substances when excited by Röntgen rays and by cathode rays, have been studied. More remarkable still is the extent to which the spectrophotometer has been used in following the decay of phosphorescence at various wave-lengths in chosen bands. When one considers how weak the illuminations in the comparison fields of this instrument are, at the limits of a band or after some time of decay, the range of application which the method finds is surprising. Numerous settings were made with intensities in the comparison fields so small as to convey to the observer no sensation of color. The concord-

ance of results, obtained under widely varying conditions, bespeaks the care and patience with which unavoidable errors in individual readings have been ironed out by the law of averages.

In following the decay of phosphorescence there is obviously a stage beyond which the spectrophotometer, on account of its wastefulness and dispersion of light, is no longer applicable. In working beyond such limits with apparatus adapted to these researches from the methods of ordinary or gross photometry, Professors Nichols and Merritt took every care to excite only that band with which they were at the time concerned. Where in a few cases this precaution could not be observed, great care was exercised to insure the desirable uniqueness of significance for the results. Two very important laws, established from the spectrophotometric measurements, add much to the significance of such measurements as were of necessity made by gross photometry. The laws express the individuality of behavior of a given luminescence band as a whole, throughout a wide range of conditions of excitation, and, in the case of phosphorescence, during decay. A band maintains measurably the same relative distribution of intensities and the same wave-length of maximum intensity. As the authors express it "the band behaves as a unit." It is, now, not unreasonable to assume that, beyond the limits of availability of spectrophotometric methods, a given luminescence band still behaves as a unit, and that the measurements made thereafter on the band as a whole should indicate with fair certainty how the intensities at the individual wave-lengths decay.

Stokes's law of photo-fluorescence, namely that the fluorescent light is of greater wave-length than the exciting light, is verified in its gross sense. But since in a large number of instances, the corresponding luminescence and absorption bands overlap, and since the whole of a given band may be excited by light of any wave-length within the region of absorption, it follows that, considered in detail, the law frequently fails.

To these three important laws, and another concerning the absence of polarization in the luminescence spectrum even when it is excited by polarized light, the authors add, from their own results and from those of other observers, some general "facts connected with the decay of phosphorescence." These are—the form of the curve of decay; the hysteresis effect or the dependence of the form of decay curve upon the previous excitation to which the substance has been subjected; the effect of red and infra-red rays (ingeniously used to restore a substance to a standard condition after each excitation); and the effect of high temperatures.

Much work was done in the study of electrical properties of fluorescent solutions. This and the efforts of other investigators in the same field has led generally to negative results in the search for change in electrical resistance of solutions during fluorescence.

Important also is the work done to reduce the initial observations, made by spectrophotometer with diffused light of the acetylene flame as a comparison standard, to the fundamental basis of energy curves, and that which was done to determine the specific exciting power (intensity of fluorescence excited per unit of absorbed energy) of various wave-lengths of exciting light.

The last two chapters of the memoir are devoted to the consideration of theories by means of which the experimental data thus far gathered may be related and explained. The discussion is notably interesting and lucid throughout. Chapter XIV. gives an outline of the dissociation theory of Wiedemann and Schmidt, and shows that it has already been applied with considerable success to the explanation of fluorescence in gases. In Chapter XV. the authors add such other hypotheses as would seem necessary to make this theory specifically applicable to the problem in hand, and deduce therefrom laws which follow experimental results with surprising success—remarkable, indeed, when one considers how complex must be the processes which occur in luminescent solutions, solid and liquid.

One of the valuable things accomplished by a memoir such as the one in review, collecting

in orderly form and discussing as it does a vast amount of material of observation, is the pointing out of gaps in available data. The pages of these "studies" raise numerous questions which must be settled in order that the whole fabric of luminescence theory may be further extended. Undoubtedly many of the questions so raised will be worked out in the same laboratories from which the present researches have been issued.

Even thus far the work represented in the present memoir constitutes a most noteworthy series of researches in the general field of luminescence. Not only the care and patience with which the observations have been made, but much more the experimental acumen with which the methods and materials have been chosen and the illuminating discussions of theoretical character, all contribute to give these researches a place beside those of the middle of the past century by which E. Becquerel blazed the way into this wonderfully interesting region. Recent developments in physics attach much more of importance to the phenomena of luminescence than could possibly have been foreseen in those earlier years, and it seems certain that further developments, in this and allied branches of physics, will greatly enhance the value of the region as a field for research.

F. E. Kester

SPECIAL ARTICLES

NON-ELECTROLYTES AND THE COLLOID-CHEMICAL THEORY OF WATER ABSORPTION

The colloid-chemical theory best explains at the present time the absorption of water by protoplasm under various physiological and pathological conditions. The laws governing the absorption of water by such simple protein colloids as fibrin and gelatine, are point for point identical with those which we have known to govern the absorption of water by cells, tissues, organs, or the organism as a whole. Thus fibrin and gelatine swell more in any acid solution than in distilled water, while protoplasm does the same. The addition of any salt to the acid solution reduces the amount of this swelling, and this the more the higher the concentration of the salt. The same holds for protoplasm. At the same concentration different salts arrange themselves in a characteristic order in this regard. The same order is observed in protoplasm.

In this way it has been possible to explain without contradiction not only all those phenomena which are ordinarily said to prove the tenability of the laws of osmotic pressure for the processes of absorption and secretion, as observed in protoplasm under various pathological and physiological circumstances, but also the notable exceptions in behavior, which no one believes explainable on the osmotic basis.

In the study of fibrin and gelatine, it was found that various non-electrolytes, such as sugars and alcohols, are *relatively* ineffective in reducing their swelling in the presence of any acid. Adherents to the osmotic theory of water absorption have made this statement read, *entirely* ineffective; and, because certain non-electrolytes bring about shrinking effects in various cells and tissues, have seen in this a valid reason for rejecting the dominant importance of the colloids and their state in determining the amount of water held by protoplasm.

During the past year a systematic study of the effect of various non-electrolytes on the swelling of gelatine and fibrin has been undertaken. *The effect of non-electrolytes upon these is identical with their effect upon protoplasm.* The various organic compounds thus far studied (saccharose, dextrose, levulose glycerine, ethyl alcohol, methyl alcohol, propyl alcohol, propylene glycol, etc.) all decrease the swelling of gelatine or fibrin in either neutral or acid solution, and this the more the higher the concentration of the added compound. When equally concentrated (equimolecular) solutions are compared the sugars are found to be more effective than the alcohols in this regard. The same is true of protoplasm. The sugars among themselves are unequally effective in dehydrating protein colloids, and in a similar way are they unequally effective in dehydrating living tissues.

We have defined the excess of water held by tissues under various abnormal circumstances and known under the varying names of excessive turgor, plasmoptysis, edema, etc., as a state of excessive hydration of the tissue colloids, more particularly of the proteins. As the causes of this we have assigned any substance or condition which, under the circumstances surrounding the living cell, is capable of increasing the hydration capacity of its colloids. As the most potent of these causes we have regarded, and still regard, an abnormal production or accumulation of acid in the involved cell. Of other substances conceivably active in certain tissues, which thus increase the hydration capacity of the tissue colloids, we have studied urea. The addition of urea increases in all concentrations the swelling of gelatine and fibrin, and this the more the higher the concentration of the urea. In the higher concentrations of urea both gelatine and fibrin are hydrated so heavily that they go into solution. The urea hydration is not a simple alkali effect, for acid in no concentration counteracts it. The hydrating effects of acid and of urea are additive. There is, however, an interesting difference between the increased hydration brought about by acids and that induced by urea. While salts reduce the former, they do not affect the increased hydration induced through urea. On the other hand, various non-electrolytes which affect the hydration brought about by acids but little, reduce that produced by urea almost entirely.

These facts, taken in conjunction with our previous studies on the colloid-chemistry of absorption and secretion, help toward an interpretation of certain well-known biological and medical facts. They explain on a colloid-chemical basis the behavior of the sugars and certain other organic substances in reducing the absorption of water by tissues. They explain the cathartic action of glycerine, the sugars, etc. They also explain the diuretic action of these substances, accounting for the polyuria of diabetes, the relative dryness of the diabetic's tissues and his thirst. We get an insight into the mechanism of urea hemolysis. Also we learn another method of dehydrating edematous tissues, which owe their excessive hydration to other circumstances than the presence of acid or the absence of salts. In addition to using sugar in order to correct the "acidosis" of certain pathological states from a biochemical point of view, we have made practical use of the above facts by using sugar along with the alkali and hypertonic salt mixtures previously recommended in combating the edemas of the eye (glaucoma), brain (uremia), medulla (pernicious vomiting), kidney (nephritis), and other organs observed in various clinical conditions. The use of dextrose along with salts and alkali in these conditions has yielded even better results than have previously been reported.

A series of papers submitted for publication in the *Kolloid Zeitschrift* will shortly bring the details of these various findings.

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CHANGES DURING QUIESCENT STAGES IN THE METAMORPHOSIS OF TERMITES

There have been several theories as to when the larvæ of termites become differentiated to the various castes in the social organization, the prevalent theory being that undifferentiated larvæ are developed to the castes by the character of the food that they receive. The results of Heath's[1] experiments, however, to determine the relation of various kinds of food to polymorphism were negative. In case of the ants, Wheeler[2] with Emery believes "the adult characters to be represented in the germ as dynamical potencies or tensions rather than morphological or chemical determinants" and that "nourishment, temperature and other environmental factors merely furnish the condi-

[1] Heath, H., "The Habits of California Termites," *Biol. Bull.*, Woods Hole, Vol. IV., December, 1902, pp. 47–63.

[2] Wheeler, W. M., "The Polymorphism of Ants," *Bull. Amer. Mus. Nat. Hist.*, Vol. XXIII., January, 1907, pp. 1–93.

tions for the attainment of characters predetermined by heredity." Bugnion,[3] studying *Eutermes lacustris* and *Termes Redemanni* Wasm. and *Horni* Wasm. states that the differentiation takes place during the embryo stage for the three castes, rather than undifferentiated larvæ being developed to the castes by the character of the food they receive.

Observations by the writer of molting soldier larvæ of *Leucotermes* spp. and *Termopsis angusticollis* Walk. show that the differentiation takes place during a "quiescent"[4] stage rather late in the life cycle. At this point a brief outline of the life cycle is necessary.

In the metamorphosis of the above species the eggs hatch into active, undifferentiated larvæ which develop to the various mature forms or castes by a gradual growth through a series of molts and quiescent stages. During the quiescent stage both the larvæ and nymphs pass through an inactive period, of comparatively short duration, isolated, lying on the side, head bent down to lie on the ventral side of the body along which the antennæ and legs also lie extended in a backward direction. The writer first observed molting larvæ in a quiescent stage on August 11, 1911, in a colony near Jerseyville, Illinois. During April, 1912. the development of nymphs of the first and second forms of *Leucotermes flavipes* Kol. and *virginicus* Banks was observed at Falls Church, Virginia, and it was noted that both these nymphs passed through a quiescent stage in the final molt to the reproductive forms; nymphs of *Termopsis angusticollis* Walk. also pass through this quiescent stage. From the first to the middle of August, 1913, freshly molted, pigmentless soldiers of *flavipes* in the stage preceding maturity were noticeable in colonies in Virginia. On August 17, 1913, molting soldier larvæ were found in the quiescent stage in a colony of *virginicus* at Chain Bridge, Virginia. During the quiescent stage differentiation took place. Larvæ to all external appearances undifferentiated or of the worker type (as shown by the head, the mandibles—with marginal teeth—and the labrum of the still adhering larval skin), the individuals (*virginicus*) being over 3 mm. in length in the quiescent condition, antennæ with 14 segments, develop at this molt to pigmentless nymphs of soldiers with more elongate, soldier-like head and saber-like mandibles, without marginal teeth. In this stage the head, mandibles, labrum and "menton" (Bugnion) have not attained the shape or length of those of the mature soldier, there being at least one later molt to maturity.

Therefore, it may be stated that in case of *Leucotermes* spp. and *Termopsis angusticollis* Walk., the differentiation of the soldier caste occurs during a molt and quiescent stage rather late in the life cycle of the insect, the larvæ being previously, to all external appearances, undifferentiated.

[3] Bugnion, Pr. E., "La différenciation des castes chez les Termites," *Bull. de la Société entomologique de France*, No. 8, April, 1913, pp. 213–18.

[4] Strickland, E. H., "A Quiescent Stage in the Development of *Termes flavipes* Kol.," *Journ. N. Y. Ent. Soc.*, Vol. XIX., No. 4, December, 1911, pp. 256–59.

THOMAS E. SNYDER
BUREAU OF ENTOMOLOGY,
BRANCH OF FOREST INSECTS,
September 11, 1913

THE AMERICAN MATHEMATICAL SOCIETY

THE twentieth summer meeting and seventh colloquium of the American Mathematical Society were held at the University of Wisconsin during the week September 8–13, 1913. The attendance, which exceeded that of any previous summer meeting of the society, included fifty-seven members. The four sessions of the summer meeting proper, for the presentation of papers, occupied the first two days of the week. The first session opened with an address of welcome by Professor C. S. Slichter in behalf of the University of Wisconsin and the local members of the society. The president of the society, Professor E. B. Van Vleck, occupied the chair at this and at the final session. Professor Oskar Bolza presided at the second, and Professor W. F. Osgood at the third session. The council announced the election of the following persons to membership in the society: Mr. W. E. Anderson,

Princeton University; Professor W. O. Beal, Illinois College; Dr. C. A. Fischer, Columbia University; Professor A. E. Landry, Catholic University of America; Lieutenant Salih Murad, Ottoman navy; Miss E. A. Weeks, Mount Holyoke College. Thirteen new applications for membership were received.

It was decided to hold the summer meeting of 1915 at San Francisco in connection with the Panama Exposition. The secretary reported that a separate office for the society had been provided by Columbia University and that the services of a clerk had been engaged for carrying on the considerable routine work of the secretary, treasurer, librarian, committee of publication and shipping office. It was decided to issue the Register of the society hereafter at intervals of two or three years; in the intervening years only a mere list of officers and members will be published. Professor L. E. Dickson was appointed editor-in-chief of the *Transactions*, the other members of the editorial committee being at present Professors H. S. White and D. R. Curtiss. The society has recently published the Princeton Colloquium Lectures delivered at the sixth colloquium in 1909 by Professor G. A. Bliss on "Fundamental existence theorems" and Professor Edward Kasner on "Differential-geometric aspects of dynamics."

The arrangements made by the local committee for the comfort and entertainment of the members throughout the week were perfect. No place in the middle west could be more ideal for such a series of meetings than Madison. The spacious lecture halls of the university, the beautiful campus occupying an elevated position overlooking the capitol building and the adjacent lakes, Mendota and Monona, the commodious University Club used as headquarters, and the hospitality of President Van Vleck and other members of the faculty who opened their homes for the entertainment of the members—these and many other items contributed to the success of the farthest west summer meeting and only western colloquium.

On Monday evening President Van Vleck entertained at dinner the members of the council and the colloquium lecturers. On Wednesday afternoon the committee provided a two-hours' special excursion on Lake Mendota, ending at the Golf Club House in time for the dinner, at which fifty-five persons sat down. President Van Vleck acted as toastmaster and informal speeches were made by Professors Osgood, Bolza, Moore, Blichfeldt, Dickson and Dr. Jackson. A telegram was sent to the secretary, expressing appreciation of his services to the society and great regret at his enforced absence. At the close of the dinner Professor Ziwet voiced the unanimous sentiment in expressing thanks to the university and the committee on arrangements for their generous hospitality. The dinner was followed by a moonlight ride on the lake back to the University Club. On Thursday the members were conducted by Professor Skinner about the campus and buildings of the university; and on Friday an automobile ride was provided by the mathematical faculty and their friends, giving the members a fine opportunity to see the immediate surroundings of Madison. This ended in a most enjoyable buffet dinner at the home of President Van Vleck.

The following papers were read at the four sessions of the summer meeting:

E. B. Lytle: "Note on iterable fields of integration."

W. H. Bussey: "The tactical problem of Steiner."

Josephine E. Burns: "The abstract definitions of the groups of degree eight."

William Marshall: "The functions of the parabolic cylinder."

L. C. Karpinski: "The algorism of John Killingworth."

R. D. Carmichael: "On series of iterated linear fractional functions."

R. D. Carmichael: "Some theorems on the convergence of series."

T. E. Mason: "The character of the solutions of certain functional equations."

E. B. Van Vleck and F. T. H'Doubler: "On certain functional equations."

Oskar Bolza: "On the so-called 'abnormal' case of Lagrange's problem in the calculus of variations."

E. R. Hedrick and W. D. A. Westfall: "An existence theorem for implicit functions."

R. G. D. Richardson: "A solution of the Rayleigh minimum problem in the theory of sound."

G. C. Evans: "The Cauchy problem for integro-differential equations."

Dunham Jackson: "A formula for trigonometric interpolation."

J. W. Alexander, II.: "Proof of the invariance of certain constants in analysis situs."

J. E. Rowe: "On Fermat's theorem and related theorems (first paper)."

J. E. Rowe: "On Fermat's theorem and related theorems (second paper)."

Maxime Bôcher: "The infinite regions of various geometries."

W. F. Osgood: "On functions of several variables which are meromorphic or analytic at infinity."

W. F. Osgood: "Note on line integrals on an algebraic surface $f(x, y, z) = 0$."

E. H. Moore: "On a class of continuous functional operations associated with the class of continuous functions on a finite linear interval (preliminary communication)."

A. R. Schweitzer: "On a general category of definitions of betweenness."

A. R. Schweitzer: "The theory of linear vectors in Grassmann's extensive algebra."

A. R. Schweitzer: "Remarks on functional equations."

A. R. Schweitzer: "The general logical significance of uniformity of convergence of series."

Edward Kasner: "On the ratio of the arc to the chord for analytic curves."

E. L. Dodd: "The arithmetic mean as approximately the most probable value *a posteriori* under the Gaussian law."

E. J. Wilczynski: "On the surfaces whose directrix curves are indeterminate."

J. B. Shaw: "On the transverse of a linear vector operator of n dimensions."

Florian Cajori: "Zeno's arguments on motion."

O. E. Glenn: "Note on a translation principle connecting the invariant theory of line congruences with that of plane n-lines."

F. R. Sharpe: "Conics through inflections of self-projective quartics."

F. R. Sharpe and C. F. Craig: "Plane curves with consecutive double points."

Mildred L. Sanderson: "A method of constructing binary modular covariants."

H. M. Sheffer: "Superpostulates: introduction to the science of deductive systems."

H. M. Sheffer: "A set of six independent postulates for Boolean algebras."

R. M. Winger: "Self-projective rational sextics."

R. M. Winger: "Self-projective rational septimics" (preliminary report).

M. Fréchet: "Sur la notion de differentielle d'une fonction de ligne."

Kurt Laves: "A new theorem concerning the motion of two satellites of finite masses circulating in nearly commensurable motions of type $\frac{1}{3}$ about a central and homogeneous body of ellipsoidal shape."

H. F. Blichfeldt: "On the order of linear homogeneous groups (fifth paper)."

T. R. Running: "Graphical solutions of differential equations between two variables."

R. P. Baker: "The genus of a group."

R. P. Baker: "The topological configurations occurring in finite geometries."

R. D. Carmichael: "On Fermat's theorem and related theorems."

H. W. March: "Integral and series representations of an arbitrary function in terms of spherical harmonics."

The colloquium opened on Wednesday morning and occupied the rest of the week. Two courses of five lectures each were given by Professor L. E. Dickson on "Certain aspects of a general theory of invariants, with special consideration of modular invariants and modular geometry," and Professor W. F. Osgood on "Topics in the theory of functions of several complex variables." Printed syllabi of the lectures had been distributed in advance of the meeting. Fifty-one persons attended the lectures, a larger number than at any previous colloquium. An abstract of the lectures will be published in the *Bulletin* of the society.

The next meeting of the society will be held at Columbia University on Saturday, October 25. The San Francisco Section will meet on the same day at Stanford University. The annual meeting of the Southwestern Section will be held at the University of Missouri on Saturday, November 29.

H. E. Slaught,
Acting Secretary

SCIENCE

Friday, October 10, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

MEDICAL EDUCATION IN THE UNITED STATES[1]

HISTORICAL

The first medical school in the United States was organized in 1765 in connection with the University of Pennsylvania by Dr. W. Shippen, the anatomist, and Dr. John Morgan, both of whom had been favorite pupils of the Hunters in London and were graduates of Edinburgh. The Harvard Medical School was founded in 1783 by Dr. John Warren, who had been a military surgeon in the army from the battle of Bunker Hill until ill health forced his retirement. Anatomy was taught by demonstrations, but in 1809 a room was opened which offered to students opportunities for dissection similar to those given by the Hunters in London. It is stated that these facilities were superior to those obtainable on the continent of Europe.

As time went on there was a great increase in the number of medical schools; the older schools either dropped their university affiliation or this became nominal. The "proprietory school" arose, in which a few practising physicians came together for the purpose of giving lecture courses and clinics to medical students during a period of five months each year. The students listened to the same courses during two successive terms and, after passing an examination, received the degree of M.D. eighteen months subsequent to the beginning of their medical studies. Attempts to raise the standard of medical education were always accompanied by a loss of fees,

[1] A report prepared for the International Conference on Post-graduate Medical Education held at the time of the Seventeenth International Medical Congress, London, 1913.

the mass of the students invariably going to the medical school which offered the medical degree in the shortest and cheapest manner. In the later days of the proprietory school, some of the faculties divided their fees so that each professor who had taught four hours a week, during five months in the year, received eight or ten thousand dollars for his services.

The schools not being endowed could not exist with a high standard. At first they served an excellent purpose in the widely separated and rapidly growing communities in which they were situated. It must be remembered how different the conditions were from those existent in the densely settled countries of Europe with their well-endowed institutions of learning.

Prior to 1870, no laboratories existed except those of anatomy, so that the expense of maintenance of the proprietory medical school could always be kept at a minimum, and large sums could be distributed among its beneficiaries. This was the general condition of affairs as late as fifteen years ago. Professorial positions were often obtained by the ability to control a hospital service, family influence or personal friendship. These conditions persist, in part, to-day. Many able men were thus drafted, but also many mediocrities achieved thereby unearned distinction in the community. The conditions existing in Harvard, one of the best schools, during the régime of the two-year course, showed that the student was compelled to listen to as many as five successive lectures on a single day between the hours of nine and two o'clock on such diversified subjects as materia medica, chemistry, medicine, obstetrics and anatomy. The last hour was assigned to anatomy, for Dr. Oliver Wendell Holmes was the only one who could hold the exhausted student's attention.[2]

[2] "Life and Letters of Oliver Wendell Holmes."

The old-time school, now little more than a memory, has been dwelt upon because of the powerful influence it has had in yielding a mass of mediocre physicians whose existence can not, in any other manner, be explained. Some American physicians kept abreast of the world's knowledge, but conditions were such that the great mass of their pupils were started ill-educated on their careers on account of lack of opportunity and lack of the inculcation of the right ideals. This faulty education could only be remedied in a few instances by personal industry or by foreign study. Eminent professors assured their students that they were receiving the best education the world afforded, and yet, in 1871, Germany had eighteen of its present twenty regularly established institutes of physiology, at the same time that Bowditch, fresh from Ludwig's laboratory, modestly offered to senior medical students "opportunities for original investigations in the laboratory." It was also in 1871 that Eliot introduced a graded three-year course at the Harvard Medical School. This was symptomatic of the broader cultural development of a provincial people which followed the struggles of the civil war, and yet it is only within the last ten years that laboratories, other than those of anatomy and gross pathology, have become acknowledged essentials of medical schools of the highest class. It is due to this fact that the discipline in anatomy was always strong and rigorous. The controlling influence over the anatomical department was the professor of surgery who had advanced directly through that path, and the younger men in charge of the dissections were practising surgeons who hoped to become skillful through exact anatomical knowledge. All emphasis was laid upon practical application, and a huge mass of memorized details were crowded into the brain of the submissive student.

The intimacy between anatomy and surgery and the rigor of the discipline did much to equip American surgeons with a practical power which was of great value. This relation is shown to-day in the examination questions asked by the old-school surgeon, which are frequently half of them questions of anatomy.

THE FIRST TWO YEARS OF MEDICAL EDUCATION

With the development of higher scientific standards, the teaching of anatomy has been turned over to specialists, preeminent of whom is F. P. Mall. The twenty leading medical schools in the United States have anatomical laboratories, in charge of full-time professors, with competent, trained assistants, engaged in teaching and research. These laboratories also embrace embryology and histology. Some of the laboratories have come under the influence of the teachings of the American biologists, of men like C. S. Minot, E. B. Wilson, T. H. Morgan, E. G. Conklin, Charles B. Davenport, R. G. Harrison and Jacques Loeb. The mention of these names is prophetic of accomplishment when American medical schools shall be so organized that they can produce masters of modern medicine.

Reference has been made to Bowditch's influence at Harvard, but physiology in America also owes an important debt to H. Newell Martin of the English school. Martin established a graduate school in physiology at the Johns Hopkins University in 1876, and inspired many of the best workers in the country in physiology and biology. At present the better medical colleges have well-equipped physiological laboratories with full-time professors. The English system of obligatory student instruction in the physiological laboratory has been adopted and extended in the United States.

For the development of physiological chemistry, the country owes much to Chittenden, who studied with Kühne, and who, with tireless energy and fine capacity, trained numerous pupils who have charge of departments of physiological chemistry to-day. Under the old proprietory school system, there was, necessarily, a professor of chemistry who taught the elements of the science. It has, therefore, been an easy task to develop a special department of physiological chemistry in connection with all of the better schools. This has been very helpful, since there has been no department of medical science the world over which has more broadly developed during late years. Practical laboratory exercises for all the students are compulsory.

The English can well realize the influence which Cushny, a pupil of Schmiedeberg, has exerted in establishing pharmacology in the United States. Through his pupils, and through Abel and Sollman and their pupils, medical students are, themselves, able to experimentally determine the behavior of drugs upon the anesthetized, functionating organism.

The new German pathology was introduced into the country, by W. H. Welch, at the Bellevue Medical College and by T. Mitchell Prudden, at Columbia, who were both in New York City during the seventies and early eighties. New York was not then a scientific center, and the Johns Hopkins University, in 1884, offered Welch a professorship of pathology, which subsequently led to the development of a life of great usefulness, of unselfishly exerted power, and well-deserved distinction. The spirit of the influence was shown in a speech at a dinner given in New York seven years ago in honor of Friedrich Müller when Welch said: "It is through the laboratory that Germany has attained her primacy in medicine, and she will not

yield that primacy *because she knows what is good for her.*" Many excellent men have been trained in Welch's laboratory and through them, as well as through pupils of Prudden, pathology is well taught in the better American schools. One very great handicap to medical progress lies in the laws relating to the autopsy of the hospital dead. In the seventies, when E. G. Janeway and Francis Delafield were laying the foundation of their masterful comprehension of the science of medicine, it was easy for them to follow the course of disease and see the results at autopsy if the patient died. But now the New York law forbids an autopsy without consent of the next of kin, instead of accepting the more rational plan of permitting autopsy unless objection is offered within twenty-four hours by the next of kin. The difficulties to be overcome before an autopsy is allowed are such that only 10 per cent. of the patients dying in Bellevue Hospital, with its twelve hundred beds, are actually autopsied. A grotesque reflection upon this foolish system is shown in the fact that these 10 per cent. of autopsies indicate incorrect diagnosis in a large percentage of the cases. The following is the record in one large public hospital of 390 autopsies in the year 1912, as compiled by Oertel.

	Cases	Per Cent.
Clinical diagnosis confirmed	87	22.3
Clinical diagnosis correct but important additional lesions found	116	29.7
Clinical diagnosis partly correct	54	13.8
Clinical diagnosis not confirmed	109	27.9
No clinical diagnosis	24	6.3
	390	100.0

If the physician were sure that, in case of death, his diagnosis would be checked by the pathologist, he would be likely to exercise greater care in his work, and he and his pupils would learn to better understand the limitations of diagnosis. Also, the value of vital statistics would be immeasurably enhanced.

This very ill-advised policy on the part of the law-making power has had a further effect of discouraging pathological morphology, so that many pathological laboratories have turned attention to experimental pathology or experimental medicine, for which latter separate departments have sometimes been instituted. The enforced neglect of morphological pathology has been a grave obstacle in the path of medical progress.

THE SECOND TWO YEARS OF THE MEDICAL COURSE

For thirty years, it has been possible to train laboratory workers in the medical sciences according to the best principles, and in increasing measure both men and opportunity have been developed. It seems passing strange that, with all this activity, it is only very recently that the clinical situation has been touched. Men have passed through the schooling of the laboratories, and then, for two final years of education, have been, and usually still are, turned over to clinicians the majority of whom have had no laboratory training, and the student has graduated, and still graduates, without knowing the application of the fundamental medical sciences to the practise of his profession. Halliburton has epitomized the situation in the words, "The student forgets his physiology at the bedside." It is well for the clinician to assure the teachers of the fundamental sciences that they do best when they emphasize the importance of the practical application of their scientific knowledge, but this is only half the story. The more important half lies in the necessity that the clinical teacher should know in what way the fundamental sciences are helpful in the understanding of medicine.

The conditions in the United States have only recently so begun to improve that there begins to be a distinct incentive for a young clinician to definitely formulate a career as a medical teacher. Three years ago, in New York City, there was no hospital which could offer a continuous service. If any one were interested in scientific research, he might work for three months in his wards, at the end of which time he was turned out by a successor who might care nothing for research. The admirable example of the close affiliation between the hospital and medical school at the Johns Hopkins was long ignored. The whole situation was most unsatisfactory from an educational standpoint.

At the present time Columbia has formed an affiliation with the Presbyterian Hospital, the Cornell Medical School one with the New York Hospital, similar alliances exist in Cleveland, St. Louis and in other localities and, in Boston, the Harvard Medical School controls the appointments to the Peter Brent Brigham Hospital. The arrangements are, for the most part, temporary and experimental. The last-named union has enabled the new Brigham Hospital and the Harvard Medical School to attract from different parts of the country some of the best minds in the United States. It is of happy augury that men who, often at the expense of poverty and mental anxiety, of illiberal criticism and even of personal abuse, have labored to attain high professional rank through scientific endeavor, should be given the opportunity to achieve a better condition of medical scholarship. There is here embodied the true spirit of the possibility of conquest of the material by the intellectual. The appointments at Harvard were made for merit and were not due to local celebrity or to the desire to satisfy relatives or personal associates. Of all the traditions inherited from the days of the proprietory school, the faculty perquisite of the appointment of local mediocrity to important clinical positions dies the hardest. It is still too easy to appoint to a professorship a man without scientific or educational interests. Yet such misuse of power is gradually becoming less and less possible.

There has been much discussion of late years regarding the duties of a university professor of a clinical subject. Effort has been made to have him renounce all private practise. This ideal state has not yet been put to the test but arrangements are now in progress for its introduction into one of the best schools. President Vincent, of the University of Minnesota, presents the unsolved problem of the clinical teacher in the following words:

> You realize how difficult it is to persuade a man who is making $25,000 a year from his practise on the outside to accept a position of $3,000 on the inside. If you can get hold of the unsophisticated medical man before he owns an automobile, much may be accomplished, but after he once yields to the insidious motor car, nothing can be done in the way of regeneration.

The best class of university professors accept only a strictly consultation practise and do not receive patients for treatment except in their own hospitals. The professor of medicine at Columbia has devoted five hours daily to his work in the school and the affiliated Presbyterian Hospital, and his associate does not practise. Herein lies the kernel of reformation. The university should emphatically require that the welfare of its affiliated hospital, the patients therein and the throng of young physicians who are being educated, should be considered as of at least equal importance to the maintenance of regular office hours by the physicians in charge. Progress in the right direction is now being accomplished. The increasing spirit of

scientific research among the younger men is sign of hope for the future.

The hospital teaching of medical students is being rapidly improved by the introduction of the English system of clinical clerks, which was first used in America by Osler at the Johns Hopkins. Patients are assigned to different students who follow carefully the course of the disease, using laboratory methods, and perhaps finally preparing a thesis upon a group of cases or some particularly interesting case, presenting also the literature concerning similar cases. Some of these theses are worth publishing and thus approach the German "Doktorarbeit."

The special medical subjects, such as the eye, ear, etc., are treated by local specialists, as is the custom elsewhere. At the Johns Hopkins, special hospitals for psychiatry and for pediatrics have recently been opened and placed under the direction of first-class men.

After receiving his diploma, the medical student usually spends a year or two as a hospital interne. The Council on Medical Education of the American Medical Association reports that of 2,004 physicians graduating during a year from 40 of the better class medical schools, 1,403 or 70 per cent. received hospital internships. At Harvard, 90 per cent. of the men followed this custom. It is strongly advised by the council that a year of hospital internship be made compulsory before license to practise medicine is allowed. The 4,000 hospitals in the country would afford ample facilities.

Mention should be made of the influence of the Rockefeller Institute in New York, the McCormick Institute for Infectious Diseases and the Sprague Memorial Institute in Chicago, the Wistar Institute of Anatomy in Philadelphia and other examples of well-endowed research institutions which, for the most part, have set an example of idealistic accomplishment that has been of aid to the development of higher aims of medical achievement. It would be of little value to set forth at this time the extent and cost of buildings devoted to medical education in the United States for the essential factor is the spirit of the institutions themselves rather than their material embodiment. In commenting on the behavior of a certain young professor who complained that he could not work on account of lack of laboratory facilities, Carl Voit once said: "Er ist faul. Er will nicht arbeiten. Man kann in einem ganz kleinen Zimmer arbeiten." It is not lavish expenditure but the right spirit that is needed.

INFLUENCE OF AGENCIES FOR PUBLIC WELFARE

There have been various helpful agencies at work which have wrought wonderful advances in medical education in the United States. The country is thought to be naturally conservative, and the medical profession especially so. The cause of this is partly explained by quoting Vincent again.

> They (the American people) usually display hostility or, at least, derisive disrespect for the specialized and their opinions. To the unspecialized average man, the expert is in a way a personal affront. He suggests the idea of a superior class and seems to reflect on the competence of the ordinary citizen. This feeling is a natural survival of the early days, especially on the frontier.

To complete the picture and show how difficult is reform in America, whether of medical education or of the tariff or of the currency, one has only to recall the remark of A. B. Macallum that the progress of the world is accomplished by one thousandth of one per cent. of its inhabitants.

The battle for correct principles and ideals regarding medical education has

been waged by certain of the medical men themselves who have been unsparing critics of the old-fashioned methods.

Helpful agencies have been especially the Council on Medical Education of the American Medical Association composed of six individuals, and Abraham Flexner, who prepared a report on the condition of the medical schools of the country for the Carnegie Foundation.

The medical problem is not a simple one. There are 49 states and each state has its own examination for the license of its physicians. There is no national control, and the standards vary greatly. Thus, in twenty-seven states, the law gives the licensing board the power to refuse recognition to the graduates of low-grade medical colleges, a power too little made use of. In four states, it is not even necessary that an applicant for medical license be a graduate of a reputable medical college, and the authorities of Tennessee, in 1912, presented the spectacle of licensing 175 individuals who were not graduates of any medical school whatever.

In 1904, when the Council on Medical Education began its activities, there were 166 medical schools in the country, which was about one half of the world's supply. There are now 110 in contrast with 21 in England, 20 in Germany, 20 in Italy and 5 in France.

The reduction in the number of medical schools by extinction or merger has been the happy outcome of severe and public criticism. The Council on Medical Education set to work to bring about conformance to certain standards which may be thus abbreviated: (1) A higher entrance requirement which includes a year's work in chemistry, physics and biology, as given in the universities. (2) The presence of at least six full-time professors in the fundamental sciences in charge of thoroughly equipped laboratories in which the student works during his first two years. (3) Two years of clinical work in hospitals and dispensaries. (4) A post-graduate year as interne in an approved hospital. (5) The medical teaching to be of high excellence.

As an instance of notable accomplishment, it may be stated that whereas in 1904 only four of the 166 medical colleges required more than a four-year high school course for entrance, and the majority of the others admitted all who applied, at present sixty medical schools have adopted the higher entrance requirements and six states have adopted two years of university work as a necessary preliminary to the medical course.

An effective stimulus to medical education has come through the grading of medical schools into four different classes. This has been done as the result of personal inspection. The Council has recently published its third grading. In Class *A* Plus there are 22 acceptable medical colleges giving a four-year course. In Class *A* there are 31 colleges lacking in certain respects but otherwise acceptable and giving a four-year course. In Class *B* there are 22 colleges needing general improvement to be made acceptable and giving a four-year course. In Class *C* there are 27 colleges requiring complete reorganization to make them acceptable. Besides this, there are eight institutions offering only the first two years of medicine and there are four schools for the colored race, two in Class *A* and two in Class *C*.

The publication of these classifications has been of inestimable benefit in creating public sentiment against unworthy institutions. The work was greatly advanced in the Flexner report which gave detailed descriptions of abominable conditions in low-grade schools. Dr. Henry S. Pritchett,

head of the Carnegie Foundation, has recently stated that the full power of the foundation, to whatever extent may be necessary, will be used in the crusade against the worthless medical schools throughout the country. It is certainly right to insist upon the closing of a diploma mill, the physiological apparatus of which consists solely of a sphygmograph, when, in the same city, a physiological laboratory exists in which the annual budget reaches $30,000, and yet these two different medical institutions have been maintained under the laws of the same state, and, until this year, their graduates have been treated on equal footing by the state board of examiners. The fact that this low-grade school does not appear in the list of fully registered colleges this year shows how the state can use its power to protect its citizens. The legal power to defend the community from the ill-educated lies with the state boards who examine for the license to practise. In 1912, 5,466 physicians were so licensed as the result of examinations in the various states. A common standard would be highly desirable which would allow a physician licensed in one state to practise in another. At present it may happen that an impostor driven from one state can readily obtain a license to practise in another, and there continue his misdeeds. This condition of affairs will not much longer be tolerated.

CONCLUSION

It is lightly stated by some that the best American schools are equal to those of Europe. It would be satisfying if one could really believe that this were true. The American has never been self-satisfied and he is outgrowing his ancient habit of boasting, but he has always desired the best and there is much hope that out of present conditions he will some time evolve the best.

APPENDIX

1913. Class A Plus.—Acceptable medical colleges well organized and thoroughly equipped, giving acceptable courses and requiring for admission one or more years of university science. Prepared by the Council on Medical Education of the American Medical Association.

State	Town	Institution
California,	San Francisco,	Leland Stanford, Jr., University.
	San Francisco,	University of California.
Connecticut,	New Haven,	Yale Medical School.
Illinois,	Chicago,	Northwestern University Medical School.
	Chicago,	Rush Medical School (University of Chicago).
Indiana,	Indianapolis,	Indiana University Medical School.
Iowa,	Iowa City,	State University of Iowa.
Louisiana,	New Orleans,	Tulane University of Louisiana.
Maryland,	Baltimore,	Johns Hopkins University Medical Department.
Massachusetts,	Boston,	Harvard Medical School.
Michigan,	Ann Arbor,	University of Michigan.
Minnesota,	Minneapolis,	University of Minnesota.
Missouri,	St. Louis,	Washington University Medical School.
New York,	New York,	Columbia University.
	New York,	Cornell University.
	New York,	New York University and Bellevue Hospital Medical School.
	Syracuse,	Syracuse University.
Ohio,	Cincinnati,	University of Cincinnati.
	Cleveland,	Western Reserve University.

Pennsylvania,	Philadelphia,	University of Pennsylvania.
Texas,	Galveston,	University of Texas.
Virginia,	Charlottesville,	University of Virginia.

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GRAHAM LUSK

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NEW YORK CITY

THE BOTANICAL EXPLORATION OF AMBOINA BY THE BUREAU OF SCIENCE, MANILA

GEORGE EBERHARD RUMPF (Latin Rumphius) died in Amboina, Netherlands East Indies, in the year 1702, after a period of residence there of about thirty years. Some years after his death there was published in Amsterdam, under the editorship of J. Burmann, his great botanical work, the "Herbarium Amboinense." This monumental work consists of six folio volumes, comprising about 1,660 pages and 669 plates with approximately 960 figures, and with the accompanying "Actuarium" was published during the years 1741 to 1755. Linnæus did not receive a copy of the published parts until too late to incorporate the plants described in his "Species Plantarum." The work, then, as to nomenclature is pre-Linnæan, although binomial designations for the plants described are abundant in it.

The "Herbarium Amboinense" has at all times since its publication been a work of great botanical interest and is to-day one of the basic works for the student of the Malayan flora. For the proper interpretation of many species proposed by later authors, by citation of Rumpf, reference to the "Herbarium Amboinense" is absolutely essential.

In 1754 Olof Stickman, one of Linnæus's students, published his dissertation entitled "Herbarium Amboinense," a small pamphlet of 28 pages, which was reprinted by Linnæus in 1759 in his "Amœntates Academicæ," IV., pp. 112–143. In this work somewhat over 300 of the plants figured by Rumpf are reduced to species proposed by Linnæus in the first edition of his "Species Plantarum" (1753), or, by citation, are made the types of new ones. Constant references are made by Linnæus to the "Herbarium Amboinense" in his later works, so that very many of Rumpf's crude figures have become, by citation, the actual types of many Linnæan species. Later still other such species were proposed by Roxburgh, and by other authors, and Rumpf's plates are constantly being cited by modern authors in monographs and in papers on the Indo-Malayan flora.

Rumpf's plates, in many cases decidedly crude, being the only means by which a large number of proposed species can be interpreted, various attempts have been made more definitely to settle the status of the plants

figured and described by him. The first attempt comprehensively to treat Rumpf's plants was by A. W. E. T. Henschel, who published his "Clavis Rumphiana" in 1833, pages xiv + 215. In this work he attempted to reduce Rumpf's species, so far as possible, to modern binomial nomenclature. Thirty years later J. K. Hasskarl, a Dutch botanist having an extensive knowledge of the flora of the Malayan region, published his "Neuer Schlüssel zu Rumpf's Herbarium Amboinense," vi + 247 pages, originally printed in the *Abhandlung der naturforschenden Gesellschaft,* IX. (1866). Both of these works are unsatisfactory for the chief reason that a simple statement that a certain plate represents a certain species is frequently of little or no value, especially when the species is actually based on the plate, as is frequently the case.

In my work on the Philippine flora during the past ten years I have come very fully to realize that most of the species described by Blanco in his "Flora de Filipinas," none of which are represented by type material, can be accurately interpreted only by an intensive knowledge of the Philippine flora, as a whole, and a very special knowledge of the vegetation of those regions from which Blanco secured his botanical material, taking into consideration also habitats, dates of flowering and fruiting, economic uses and native names, in fact all data given by Blanco regarding each individual species. In many cases one must secure material from the actual localities cited by Blanco, and our recent collections must be compared with Blanco's descriptions not only as to the botanical characters given by him, but all other data. Similarly I have come to the conclusion that many of the species based on Rumpf's figures can be correctly interpreted and understood only by an intensive botanical exploration of the regions in which Rumpf collected his material, and a study of the specimens secured, taking into consideration all the data given by Rumpf and comparing it with data secured with botanical material from Amboina and neighboring islands.

Many of the species based wholly or in part on Rumpf's figures have been credited with a wide Indo-Malayan range, but in some cases, at least, the "species" are collective ones. Many others are not understood at all and appear in monographs as unrecognizable, doubtful or imperfectly known forms. We have in the Philippines many of the species proposed by the older authors which are typified by Rumpf's figures, and in critical genera, especially in those with numerous species, it is frequently quite impossible definitely to state which of our forms is the species based on Rumpf, and which is a distinct but closely allied one. The same principle holds true for the entire Malayan region.

In the case of many plants figured by Rumpf, there is absolutely no doubt as to the present status of such as the cocoanut, the papaya, the tamarind, the mango, the beetlenut palm, and other well-known forms in monotypic or small genera. The difficulties arise in such genera as *Calamus, Canarium, Gnetum, Mucuna, Pandanus,* etc., where specific differences are frequently not very great. It is frequently quite impossible absolutely to delimit the species from the figures and descriptions given by Rumpf, and apparently no serious attempt has ever been made to interpret the species from actual Amboina specimens.

To illustrate this matter *Mucuna pruriens* DC. is based on *Dolichos pruriens* L. The original publication of *Dolichos pruriens* L. is in Stickman's "Herbarium Amboinense" (1754), 23, and is based absolutely and only on *Cacara pruiens* Rumpf Herb. Amboin., V., 393, *t. 142;* the question of specific identity of *Mucuna pruriens* is not complicated by any additional synonyms in the original publication of *Dolichos pruriens.* Most botanists assign to the species a pantropical distribution, as did Linnæus in his later publications; yet a simple examination of the material in any large herbarium will at once show that *Mucuna pruriens* is a "collective species," and that specimens so named really represent several more or less distinct species. No botanist can definitely state that he actually

knows just what *Mucuna pruriens* is, yet the species undoubtedly still grows in Amboina, and specimens from there which agree with Rumpf's figure and description will closely typify the Linnæan species. I assign to *Mucuna pruriens* a form that is not uncommon at low altitudes in the Philippines because, so far as I can determine, it agrees absolutely with Rumpf's figure; moreover the Philippine flora is very similar to that of the Moluccas. Yet other botanists refer to *Mucuna pruriens* quite different plants, and specimens that much less resemble Rumpf's figure than does the Philippine material. Now a prominent botanist has proposed to describe this Philippine form, my idea of *Mucuna pruriens,* as a new species, yet neither he nor I can definitely state whether it is or is not the form figured by Rumpf. I assume that it is, he assumes that it is not *Carcara pruriens* of Rumpf.

In 1788 Lamarck described a certain Rutaceous plant as *Fagara triphylla,* basing his description on a single Philippine specimen collected by Perrottet, and adding a reference to *Ampacus angustifolius* Rumpf Herb. Amboin., II., 188, *t. 62,* as illustrating the same species. In 1824 DeCandolle transferred Lamarck's species to *Evodia,* as *E. triphylla,* and until recently the species has been retained in that genus. An examination of Lamarck's actual type in the Muséum d'Historie Naturelle, Paris, shows it to be not an *Evodia* at all, but a *Melicope,* and a species known only from the Philippines. All botanists, however, have interpreted *Evodia triphylla* from Rumpf's figure, not from the actual type, and it has been given a range of from Tenasserim and Burma to Japan, China and Malaya. *Evodia triphylla* of modern authors contained at least three distinct species in two genera, and the number of synonyms is quite appalling.[1] Whether or not the Amboina *Ampacus angustifolius* is the same as the Philippine *Melicope triphylla* Merr. (*Fagara triphylla* Lam., *Evodia triphylla* DC.), it is impossible to determine at present, but the case illustrates remarkably well the errors in interpretation made by eminent botanists in attempting the identification of extra-Moluccan specimens with Rumpf's figures.

Recently Dr. O. Becarri has published his great monograph of the genus *Calamus,*[2] having access to most of the large European, Indian and Malayan collections. Rumpf figures eleven forms, on which ten species of *Calamus* have been based by later authors; yet Dr. Beccari, in spite of his great knowledge of the group, a personal knowledge of the Malayan species based on his own extensive Malayan collections, and in spite of the vast amount of material examined by him, was able definitely to recognize but four of these ten species. He states, *l. c.,* 90:

> The others represent, I believe, very well-marked species which will be recognized at some future time, because considering the period at which they were made, Rumpf's figures are very good and the descriptions, if properly understood, are quite reliable. I have therefore no doubt that these species will be found again in the Moluccas when these islands are better explored.

Some months ago I conceived the plan for a botanical exploration of Amboina, with the primary object of collecting in the original localities cited by Rumpf, actual botanical material that might represent the species, often so crudely figured by him, the actual field work to be done with a consideration of all the data given by Rumpf, localities, habitats, native names, uses, time of flowering and fruiting, etc. The plan as developed by the Bureau of Science was approved by the authorities in the Philippines, and has received the cooperation and support of the Dutch botanists at Buitenzorg, Java. The problem was assigned to Dr. C. B. Robinson, of the botanical staff of the Bureau of Science. Plans were perfected and he left Manila in June for Java and is now in Amboina, where he will prosecute botanical exploration for some months.

It is the ultimate plan to distribute the bo-

[1] Merrill, E. D., "On the Identity of *Evodia triphylla* DC.," *Philp. Journ. Sci.,* VII., 1912, *Bot.,* 373–378.

[2] *Ann. Bot. Gard. Calcutta,* XI., 1908.

tanical material thus secured to various institutions, authentically named with reference to modern nomenclature, and at the same time correlated, whenever possible, with Rumpf's figures and descriptions. It is felt that this particular piece of taxonomic research is one of the very greatest importance and the material we hope to secure should enable botanists generally very definitely to interpret and delimit many of the now doubtful species that have been proposed by citation of Rumpf's figures.

It is hoped that in case we succeed in solving some of the taxonomic problems which are dependent on a correct interpretation of species based on Rumpf's work, that our success may stimulate some other botanist to do for Rheede what we hope to do for Rumpf; that is, to collect and distribute a set of plants from the Malabar coast in India that shall represent those species figured by Rheede tot Draakenstein in his "Hortus Malabaricus," I.-XII., 1678-1703, a work of as great or greater importance than that of Rumpf in interpreting various Linnæan and other species.

Elmer D. Merrill

Bureau of Science,
Manila, P. I.

MARINE BIOLOGICAL LABORATORY INVESTIGATORS 1913

ZOOLOGY

Independent Investigators

Allee, W. C., Instructor in Zoology, Williams College.

Baitsell, George A., Graduate Student, Yale University.

Beckwith, Cora J., Instructor in Biology, Vassar College.

Binford, Raymond, Professor of Biology, Guilford College.

Boring, Alice M., Associate Professor of Zoology, University of Maine.

Breitenbecker, J. K., Instructor in Biology, Western Reserve University.

Browne, Ethel N., Dana Hall, Wellesley College, Instructor in Biology.

Budington, Robert A., Associate Professor of Zoology, Oberlin College.

Bullock, F. D., Associate in Cancer Research, Columbia University.

Calkins, Gary N., Professor of Protozoology, Columbia University.

Chambers, Robert, Assistant Professor of Histology and Comparative Anatomy, University of Cincinnati.

Child, C. M., Associate Professor of Zoology, University of Chicago.

Clapp, Cornelia M., Professor of Zoology, Mount Holyoke College.

Conklin, E. G., Professor of Biology, Princeton University.

Crampton, H. E., Professor of Zoology, Barnard College, Columbia University.

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Grave, Caswell, Professor of Zoology, Johns Hopkins University.

Grave, B. H., Professor of Biology, Knox College, Galesburg, Ill.

Gregory, Louise H., Instructor in Zoology, Barnard College.

Harvey, E. N., Instructor in Physiology, Princeton University.

Hegner, R. W., Assistant Professor of Zoology, University of Michigan.

Hogue, Mary J., Instructor in Zoology, Mount Holyoke College.

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Jackson, Robert T., Professor of Paleontology, Harvard University.

Just, E. E., Professor of Zoology, Howard University.

Knower, H. McE., Professor of Anatomy, University of Cincinnati.

Lefevre, George, Professor of Zoology, University of Missouri.

Lillie, Frank R., Professor of Embryology, University of Chicago.

Lund, E. J., Adam T. Bruce Fellow, Johns Hopkins University.

McClung, C. E., Professor of Zoology, University of Pennsylvania.

McGregor, J. H., Professor of Zoology, Columbia University.

Mall, F. P., Professor of Anatomy, Johns Hopkins University.

Malone, E. F., Assistant Professor of Anatomy, University of Cincinnati.
Morgan, T. H., Professor of Experimental Zoology, Columbia University.
Morrill, C. V., Instructor in Anatomy, New York University.
Morse, Edward S., Director, Peabody Museum, Salem, Mass.
Newman, H. H., Associate Professor of Zoology, University of Chicago.
Painter, T. S., Instructor in Zoology, Roanoke College.
Pappenheimer, A. M., Associate in Pathology, Columbia University.
Parmenter, C. S., Vice-president and Professor of Zoology, Baker University, Baldwin, Kansas.
Paton, Stewart, Lecturer in Biology, Princeton University.
Patterson, J. T., Professor of Zoology, University of Texas.
Reinke, E. E., Fellow in Zoology, Princeton University.
Robertson, W. R. B., Assistant Professor of Zoology, University of Kansas.
Shorey, Marian L., Professor of Biology, Milwaukee-Downer College.
Shull, A. Franklin, Assistant Professor of Zoology, University of Michigan.
Spaeth, R. A., Research Student, Harvard University.
Spaulding, E. G., Assistant Professor of Philosophy, Princeton University.
Stockard, C. R., Professor of Anatomy, Cornell Medical College.
Strong, O. S., Instructor in Anatomy, Columbia University.
Strong, R. M., Instructor in Zoology, University of Chicago.
Thompson, Caroline B., Associate Professor of Zoology, Wellesley College.
Treadwell, A. L., Professor of Biology, Vassar College.
Van Cleave, H. N., Instructor in Zoology, University of Illinois.
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Beginning Investigators

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Hoge, Mildred A., Graduate Student, Columbia University.
Isaacs, Raphael, Assistant in Zoology and Embryology, University of Cincinnati.
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Hyde, Ida H., Professor of Physiology, University of Kansas.

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Tashiro, Shiro, Associate in Physiology, University of Chicago.

Wasteneys, Hardolph, Associate in Experimental Biology, Rockefeller Institute for Medical Research.

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Beginning Investigators

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BOTANY

Independent

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Hibbard, Rufus P., Instructor in Plant Physiology, Michigan Agricultural College.

Lewis, I. F., Assistant Professor of Botany, University of Wisconsin.

Lyman, George R., Assistant Professor of Botany, Dartmouth College.

Moore, George T., Director, Missouri Botanical Gardens.

Nichols, Susan P., Associate Professor of Botany, Oberlin College.

Osterhout, W. J. V., Professor of Botany, Harvard University.

Snow, Laetitia M., Associate Professor of Botany, Wellesley College.

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Foster, Goodwin L., Graduate Student, Dartmouth College.

Hopping, Aleita, Tottenville, Staten Island, New York.

Robbins, W. J., Instructor in Plant Physiology, Cornell University.

Roberts, Edith A., Instructor in Botany, Mount Holyoke College.

THE MICROORGANISM CAUSING EPIDEMIC POLIOMYELITIS[1]

FROM the facts presented it follows that by employing a specially devised method there has been cultivated from the central nervous tissues of human beings and monkeys the subjects of epidemic poliomyelitis a peculiar minute organism that has been caused to reproduce the symptoms and lesions of experimental poliomyelitis. The microorganism consists of globoid bodies measuring from 0.15 to 0.3 of a micron in diameter, and arranged in pairs, chains and masses, according to the conditions of growth and multiplication. The chain formation takes place in a fluid medium, the other groupings in both solid and fluid media. Within the tissues of infected human beings and animals the chains do not appear.

No statement is ventured at present as to the place among living things to which the

[1] Concluding part of a paper by Dr. Simon Flexner and Dr. Hideyo Noguchi published in the *Journal of Experimental Medicine* for October.

bodies belong. It is obvious that the cultural conditions are those that apply more particularly to the bacteria.

On the other hand, the microorganism is associated with the production of an acute disease in which suppuration does not form a prominent part. No special attention at the present time has been given to the solution of the question as to whether the microorganism actually belongs to the bacteria or to the protozoa. In the manner of evolution of the symptoms, and in the appearance of the lesions, the experimental disease caused by the inoculation of the cultures resembles that produced by the virus of poliomyelitis as ordinarily employed. The central nervous organs of monkeys infected with the cultures bear preservation and glycerinization as do the infected human tissues, or the monkey tissues infected directly from human tissues. Cultures to which glycerin is directly added survive in the refrigerator at least eight days.

The microorganism passes through Berkefeld filters and the filtrates yield upon recultivation the particular microorganism contained within the filtered culture. Moreover, Berkefeld filtrates prepared from the nervous tissues of infected human beings and monkeys yield also in culture the identical microorganism.

By employing a suitable staining method the microorganism has been detected in film preparations and sections prepared from human nervous tissues, and from the corresponding tissues of monkeys inoculated with the usual virus or with cultures or filtrates prepared from monkeys previously injected with cultures. From all the infected materials mentioned, irrespective of the manner of their origin, the microorganism has been recovered in cultures. As would be expected it is more uniformly recoverable from the original nervous tissues than from filtrates, and doubtless for the reason that in the former it exists in greater abundance.

To obtain the initial culture is difficult, and this irrespective of whether the tissues submitted to cultivation have come immediately from man or from monkeys previously inoculated with the ordinary virus or even with the cultures. Once the microorganism adapts itself to a parasitic state it is developed with greater difficulty under saprophytic conditions. Whenever the nervous tissues have been shown to be infectious, the microorganism has been recoverable, notwithstanding long preservation and glycerination. In other words, infectivity of the nervous organs and the presence of the microorganism exist together. It has indeed happened that a specimen of infected nervous tissue has at the first attempt not yielded the initial growth, although it has yielded it upon the second attempt. Persistence will usually lead to a successful cultivation, provided no technical fault is committed. An important factor in the technique of cultivation is the sample of ascitic fluid. Not all samples are suitable, and a preliminary test is necessary, using for the purpose a growing culture, in selecting samples for culture purposes. Once a suitable ascitic fluid is obtained it should be carefully husbanded in the refrigerator. Even with this precaution failure may still occur. In such an instance repetition, using the same materials but in two series, one of which is prepared for enclosure in the anaerobic jar, while the other is allowed to remain outside, may yield the desired result; or the result may come on a second trial that appears to be an exact repetition of the first.

Only the exceptional cultures possess the degree of pathogenicity sufficient to cause specific infection, and the production of experimental poliomyelitis. A pathogenic strain may be effective at different and even remote generations, and a non-pathogenic strain may lack pathogenicity even in the second generation. This important fact indicates strongly that the pathogenic effect is not due to mere mechanical carrying over into the cultures of an invisible parasite or virus with which the cultivated microorganism is accidentally associated. If such accidental association were the cause of the experimental disease produced by the cultures in monkeys, it would display itself preferably in

the first generations and without reference to the strain of the visible microorganism. On the other hand, in this fluctuation of pathogenicity the cultures imitate the action of the virus as contained in human materials, namely, nervous tissue, secretions from the nasopharynx and intestinal washings, in which the virus, either known or believed to be present, may yet fail to be demonstrated by reason of the want of infectious power for monkeys or for the particular monkey inoculated in a given instance. Moreover, it is a common experience in bacteriology to find even among the ordinary bacteria lack or rapid loss of virulence among saprophytic cultures, while virulence is not only retained, but may be increased in rapid passages from animal to animal.

In view of these considerations it would appear that an etiological relationship has been shown to exist between the cultivated microorganism and epidemic poliomyelitis as it occurs in human beings or in monkeys. There remains merely a single other possibility, already indicated, namely, that two factors are present in the cultures, the one an invisible because ultramicroscopic organism, the other the globoid bodies described. On this basis it would have to be supposed that the former but hypothetical factor is the essential agent of infection. As against this supposition it may be urged that an instance of symbiosis of this nature is not known to animal pathology. Regarding the cultivated minute but visible microorganism itself, it may be held on the basis of the data presented that it fulfills the conditions hitherto demanded for the establishment of causal relation between an extraneous parasite and a specific disease. The microorganism exists in the infectious and diseased organs; it is not, as far as is known, a common saprophyte, or associated with any other pathological condition; it is capable of reproducing, on inoculation, the experimental disease in monkeys, from which animals it can be recovered in pure culture. And besides these classical requirements, the microorganism withstands preservation and glycerination as does the ordinary virus of poliomyelitis within the nervous organs. Finally, the anaerobic nature of the microorganism interposes no obstacle to its acceptance as the causative agent, since the living tissues are devoid of free oxygen and the virus of poliomyelitis has not yet been detected in the circulating blood or cerebrospinal fluid of human beings, in which the oxygen is less firmly bound; nor need it, even should the microorganism be found sometimes to survive in these fluids.

SCIENTIFIC NOTES AND NEWS

At the celebration of founder's day at Lehigh University, on October 3, the degree of doctor of laws was conferred upon Dr. Mansfield Merriman, from 1878 to 1907 head of the department of civil engineering, and on Professor Edward H. Williams, Jr., head of the department of mining and geology from 1881 to 1902.

Professor Eliakim Hastings Moore, head of the department of mathematics of the University of Chicago, was recently elected by the council as a corresponding member of the British Association for the Advancement of Science.

Dr. Arthur Shipley, professor of zoology and master of Christ's College, of Cambridge, will make one of the addresses at the formal opening of the graduate college of Princeton University, on October 22.

Dr. A. F. Blakeslee, who has been spending a year's leave of absence in research work in the Carnegie Station for Experimental Evolution at Cold Spring Harbor, L. I., has returned to the Connecticut Agricultural College, Storrs, Conn., where he is in charge of the department of botany.

Last summer the U. S. Weather Bureau, in cooperation with the Smithsonian Institution, made a series of balloon ascensions in southern California, with Mr. W. R. Gregg in charge of the field party. The latter part of July was spent at Catalina Island, and the first twelve days of August on the summit of Mount Whitney.

PRESIDENT WILSON has nominated Col. Dan. C. Kingman, corps of engineers, as chief of engineers, with the rank of brigadier general.

DR. R. LÖWENHERZ has been appointed curator of the chemical museum of the Berlin School of Technology.

MR. W. F. FISKE has been requested by the Tropical Diseases Committee of the Royal Society to investigate the life-history of the tsetse flies in Uganda.

DR. HIDEYO NOGUCHI, of the Rockefeller Institute, New York, on September 23 presented the results of his researches on the etiology of rabies before the German Association of Men of Science and Physicians.

A REPORT on tropical diseases prevalent in Ecuador and adjacent republics is being made to Superintendent Smith, of the Johns Hopkins Hospital, by Dr. A. W. Sellards who was the representative of the Johns Hopkins Hospital in the expedition sent out by the Harvard Medical School, under the direction of Dr. Richard P. Strong.

THE Royal Geographical Society's specially designed Antarctic medals will be presented to the surviving members of the Scott expedition by Lord Curzon of Kedleston at a meeting of the society on November 10. At the same time, at the request of the Italian Geographical Society, the president will present to Lady Scott the great Humbert gold medal awarded by that society in memory of Captain Scott. Silver duplicates will be presented to Mrs. Wilson, Mrs. Oates, Mrs. Bowers and Mrs. Evans, widow of petty officer Evans.

THE Harveian oration before the Royal College of Physicians, of London, will be delivered by Dr. J. Mitchell Bruce, on October 18.

THE *School Review*, published by the University of Chicago Press, will hereafter be under the editorial charge of Rollo LaVerne Lyman, this year appointed associate professor of the teaching of English in the School of Education. Frank Nugent Freeman, instructor in educational psychology, has been placed in editorial charge of the *Elementary School Teacher*.

PROFESSOR LUCIEN AGUSTUS WAIT, emeritus professor of mathematics in Cornell University, with the faculty of which he was connected from 1870 until his retirement in 1910, has died, aged sixty-seven years.

DR. REGINALD FABER FITZ, professor emeritus in the Harvard Medical School, where for many years he was Shattuck professor of pathological anatomy, died on September 30, aged seventy years.

THE death is announced of Edward Gardner Murphy, who was active in educational and social matters, and under the name Kelvin McKready was the author of various publications in astronomy.

THE deaths are also announced of Mr. Samuel Roberts, F.R.S., president of the London Mathematical Society from 1880 to 1882, and De Morgan medallist in 1896, and of Mr. John Greaves, bursar and senior mathematical lecturer at Christ's College, Cambridge.

THE government through Secretary of Commerce Redfield has decided to change the sale of all the government catch of seal, fox and other Alaska furs, from London to St. Louis. At the present time St. Louis is said to be the largest primary fur market in the world. It is estimated that three fourths of all the furs trapped on the North American Continent are shipped to St. Louis houses to be sold.

THE British secretary of state for the colonies has nominated a committee to report: (1) Upon the present knowledge available on the question of the parts played by wild animals and tsetse flies in Africa in the maintenance and spread of trypanosome infections of man and stock. (2) Whether it is necessary and feasible to carry out an experiment of game destruction in a localized area in order to gain further knowledge on these questions, and, if so, to decide the locality, probable cost, and other details of such an experiment, and to provide a scheme for its conduct. (3) Whether it is advisable to attempt the extermination of

wild animals, either generally or locally, with a view of checking the trypanosome diseases of man and stock. (4) Whether any other measures should be taken in order to obtain means of controlling these diseases.

The production of gypsum in 1912 was the greatest in the history of the industry, according to the U. S. Geological Survey, the amount of gypsum consumed being 2,500,757 short tons. The value of gypsum and gypsum products was \$6,563,908, an increase of \$101,873 over 1911. In 1880 only 90,000 tons of gypsum were produced; in 1900 the production was 590,000 tons. The bulk of the gypsum produced in the United States is manufactured by grinding partial or complete calcination into the various plasters, such as plaster of Paris, molding and casting plaster, stucco, cement plaster, flooring plaster and hard-finish plaster. Refined grades of plaster are used in dental work, for making pottery molds, stereotype molds, molds for rubber stamps, and as an ingredient in various patent cements. A steadily increasing quantity is being used in the raw state as a retarder in Portland cement. Considerable quantities are ground without burning and used as land plaster; smaller quantities are used in the manufacture of paint, wall tints, crayons, paper, imitation meerschaum and ivory, and as an adulterant. The pure white massive form, known as alabaster, is much used by sculptors for interior ornamentation, less, however, in this country than abroad.

According to the *Scottish Geographical Magazine* the research vessel *Hiawatha*, chartered for fishery research in the North Sea, left the Tyne in August for the purpose of making certain practically continuous hydrographic observations, at a fixed position. She was to take part in a coordinated research into the movements of the great water masses in the North Sea, and for this purpose was to drop her anchor about 150 miles "E. by N. ½ N." of Shields. Her labors were to be identical in aim with researches simultaneously carried out on board eight other vessels, also at anchor. Two of these other vessels were to be research vessels, acting on behalf of Sweden and Scotland, the Swedish vessel working in the Skagerak, the Scottish well to the northeast of Aberdeen. The remaining vessels are light vessels, two acting for Holland and the other four for the English department. The observations were to consist of current measurements made near both surface and bottom every hour night and day throughout the fortnight, and in fine weather at other intermediate depths. Special attention was to be paid to the submarine waves which, it is expected, are to be met with at the depth at which the heavier bottom water and the lighter surface water are in contact. Specially devised current meters are used in this work. The temperature and salinity of the various layers of the sea were also to be ascertained, special water-bottles being employed to secure samples of the sea from any desired depth. Samples of the minute floating organisms which, directly or indirectly, constitute the food of all our food fishes were also to be taken at various depths and at the extremes of the tide. It is expected that some 8,000 independent current measurements would be made from the English vessels alone. The operations have been planned by a special committee of the International Council for the Exploration of the Sea, it is stated, because a knowledge of the constitution and movements of the sea water is essential to the understanding of the movements and of the abundance of the fishes upon which the fishing industry depends. For instance, the abundance or scarcity of the herring of the Kattegat and Skager Rack has been found to be connected directly with the amount of water which enters the Baltic from the North Sea, and other fisheries in southern Sweden have been shown to change with the ebb and flow of this layer of cold, salt water.

The U. S. Bureau of Mines has issued Bulletin 22, entitled "Analyses of Coals in the United States, with Descriptions of Mine and Field Samples collected between July 1, 1904, and June 30, 1910." This report contains the analyses of 5,000 samples of coal taken from 1,500 coal mines and prospects situated in the various coal fields of the United States. Not

only all of the important fields are represented, but practically all of the more important mining districts. The purpose of the bureau in compiling and publishing this information is to present reliable information regarding the chemical composition and heating value of the coals. The samples of coals were collected by experienced men according to a definite and uniform system, and were analyzed under carefully controlled conditions, so that there might be no question as to the relative merits of the different coals so far as this can be determined by chemical analyses and determination of heating values. An increasing proportion of the coal consumed in the power stations and the larger manufacturing plants of the country is now being purchased under specifications based on chemical analyses and calorimetric determinations of heat units. In the purchase of fuels many matters that have been left to chance are now carefully investigated. It is the aim of mechanical engineers to construct furnaces and to arrange the heat-absorbing surface in a furnace with reference to the peculiar character of the fuel which is to be burned. The report just issued by the Bureau of Mines is in two parts, one giving the methods used in collecting and analyzing the samples, and the results of the analyses, and the other giving the exact location from which each sample of coal was taken, together with a description of the characteristic features of the coal bed at the point of sampling, the nominal capacity of the mine, and such notes on the preparation of the coal as might be useful to consumers. The data contained in these two volumes is not equalled in scope and detail and in value for comparative purposes by the figures that have been published by any other coal-producing country in the world. The governments of some of these countries have published analyses of coals from different mines and from different districts but, with few exceptions, the samples of coal were not collected and analyzed under a uniform system that would make the results comparable in all respects, and no country has attempted to publish such a large number of analyses that would be comparable because of the care taken in collecting and analyzing the samples.

During the past fiscal year 4,686 predatory animals were killed by federal officers on the national forests, according to an actual count of carcasses. An indeterminate number of animals, whose bodies were not found, are presumed to have died from poison. The ranger's bag of beasts of prey this year, as shown by forest service figures, was made up of 206 bears, 3,541 coyotes, 133 mountain lions, 62 lynx, 583 wild cats, 64 wolves and 97 wolf pups. The figures indicate that the national forests are becoming cleared of wild animals that prey upon domestic livestock and game, for the forest ranger fills in odd moments between other jobs by thinning out "undesirable citizens" of the animal world. Wolves are said to cause greater losses to western stockmen than any other of the predatory animals. It is estimated that a family of wolves will destroy about \$3,000 worth of stock per annum, and that one able-bodied individual costs the grazing industry \$600 a season. The wolves are of two classes, the smaller prairie wolves or coyotes, and the larger gray, black or timber wolves, called "lobos." These latter are the great stock-destroyers against which the campaign of the rangers has been waged. The methods of hunting wolves in the west vary. On the plains wolves are sometimes hunted with dogs and horses, but this way is considered expensive and often dangerous. This sport is described by Roosevelt in his earlier hunting books. On national forests the rangers either set out poison or baited steel traps or, by watching trails and hiding near a wolf's den, are able to shoot one or both of the old wolves when they return from foraging. In no other way, according to the forest service, can the number of wolves be kept down so well as by finding their dens and destroying the young. The skins of the predatory animals killed by the rangers are either kept as souvenirs or sold for a price or for bounty. Wolf skins in the west are said to bring from \$4 to \$6 for robes and rugs; a mountain lion skin, \$10 to \$20; and a bear skin, anywhere from \$20 to \$150, according to size and species. In addi-

tion to this there are bounties on bear, lions and wolves in most of the western stock states. Wyoming, in ten years, has paid out, it is said, over $65,000 in bounties on wolves alone and $95,000 more on coyotes and mountain lions. Through his activity against these pests, the forest ranger, it is said, has saved the stockmen many thousands of dollars during the year, while the protection to game animals, such as deer, elk and antelope, is of almost equal importance.

With the middle of September the fire season on the national forests has come practically to an end with less damage than ever recorded. There is always some danger from carelessness of campers or of settlers burning brush and clearing land, but the real danger season extends only from the middle of June until the middle of September. Forest officers throughout the west are congratulating themselves on a season so markedly free from heavy losses. They feel that the immunity from loss has been due to two principal causes, partly to a favorable season, but largely to a much better organization for fire prevention than has been attained heretofore. The effectiveness of the organization is shown particularly by the fact that while there were in all approximately 2,260 fires, as against 2,470 last year, yet the area burned so far this year is only about 60,000 acres as against 230,000 acres in 1912, and 780,000 in 1911. The various causes of fires have not changed greatly in their relative proportions. Railroads and lightning head the list, with campers next. There has been, however, a marked decrease in the number of fires caused by burning brush, which, according to the forest officers, indicates a closer cooperation with the settlers in and near the forests and with timberland owners in fire prevention and control. It is still true, nevertheless, that a large proportion of all fires started are due to human agencies and may generally be charged against carelessness. Fires caused by lightning are of course not preventable, but the system of lookouts by which they may be detected immediately after being set is greatly lessening the loss from this source.

UNIVERSITY AND EDUCATIONAL NEWS

The Harvard Medical School has received $50,000 from the estate of George S. Hyde.

The Flora Stone Mather Memorial Building of the College for Women of Western Reserve University was formally dedicated on September 30. The building is the gift of Mr. Samuel Mather and his children and is a memorial to Mrs. Mather, daughter of Amasa Stone, the refounder of Adelbert College, and the sister of Adelbert Stone, for whom Adelbert College is named. Mr. Mather has built the building, equipped it completely throughout, and has added to the gift the sum of $50,000, as an endowment. The Flora Stone Mather Memorial Dormitory, the gift of the alumnæ of the College for Women, will be built upon land situated south of the gymnasium. Immediately following the services at the new memorial building the land upon which the memorial dormitory is to be built was dedicated.

The College of Agriculture and Mechanic Arts, Mayaguez, Porto Rico, is this year offering an apprentice course in general agriculture. The plans for the course were approved at the April meeting of the board of trustees. The dominant feature of the course is that each student is employed eight hours per day in ordinary manual labor on the farm. From one to two hours are devoted to special class instruction. The work done by these students will be the ordinary manual labor of the farm, except that the work will be diversified so as to give each student as broad and varied experience as is possible.

Dr. John Casper Branner, professor of geology, was installed as president of Stanford University on October 1.

At the University of Illinois the following appointments have been made: L. H. Provine, superintendent of construction with the Stone and Webster Engineering Corporation at Seattle, professor of architectural engineering; L. A. Harding, professor and head of the de-

partment of mechanical engineering of the Pennsylvania State College and, during the past year, consulting engineer in New York City, professor of experimental mechanical engineering; A. C. Willard, sanitary and heating engineer of the United States War Department, assistant professor of heating and ventilation; E. A. Holbrook, professor of mining engineering and metallurgy at the Nova Scotia Technical College, Halifax, assistant professor of mining engineering; J. I. Parcel, assistant professor of structural engineering at the University of Minnesota, assistant professor of structural engineering; W. M. Wilson, chief designer with the Strauss Bascule Bridge Company of Chicago, assistant professor of structural engineering; P. S. Biegler, professor of electrical engineering in the University of Montana, associate in electrical engineering; S. O. Andrus, field assistant of the U. S. and State Geological Surveys and of the department of mining engineering, associate in mining engineering, and A. R. Knight, instructor in electrical engineering at the University of Pennsylvania, instructor in electrical engineering.

THE faculty of the College of Agriculture and Mechanic Arts of Porto Rico has changes this year as follows: Mr. D. T. Griswold, animal husbandryman, has resigned. His present address is College Station, Texas. The following are additions to the faculty: Professor Higgins, horticulture; Dr. Fredholm, agronomy; Professor Ham, manual training; Professor MacMillan, manual training; Professor Stafford, mathematics; Miss Baco, mathematics.

MR. FRED D. FROMME, a graduate of the South Dakota State College, and for the last two years a student and assistant at Columbia University, has become assistant in the botanical department of the Indiana Experiment Station. Mr. H. C. Travelbee, a graduate of Purdue University, has also become assistant in the same department. The two positions were vacated in July by Dr. F. D. Kern and Mr. J. B. Demaree, who are now at the Pennsylvania State College.

DR. FANNY COOK GATES, formerly professor of physics at Goucher College, Baltimore, has been appointed dean of women at Grinnell College, Iowa, with a full professorship in physics.

DR. FRANK DUNN KERN has been elected professor of botany at the Pennsylvania State College.

THE following new appointments have been made at the University of Pittsburgh for the coming year: *College:* John M. Mecklin, Ph.D., Leipzig, formerly professor of philosophy at Lafayette College, profesor of philosophy; W. Paul Webber, Ph.D., University of Cincinnati, formerly professor of mathematics at Bethany College, instructor in mathematics; Marks Neidle, Ph.D., Columbia University, formerly instructor in chemistry at Erin Preparatory School, instructor in analytical and physical chemistry; Emmett F. Hitch, Ph.D., Cornell University, formerly instructor in chemistry at Cornell University, assistant professor of organic and technical chemistry. *School of Engineering:* George W. Case, Cornell University, formerly assistant professor of sanitary engineering at Purdue University, assistant professor of sanitary engineering. *School of Education:* Thomas J. Kirby, Columbia University, formerly supervisor of industrial schools, N. Y., professor of elementary education. *School of Medicine:* J. D. Heard, professor of medicine; X. O. Werder, professor of gynecology; J. McMeans, instructor in clinical pathology; Miss M. E. Bothwell, research assistant; Chris. Gardner, assistant demonstrator in anatomy.

DR. CHARLES CROWTHER has been appointed professor of agricultural chemistry in the University of Leeds, and will have charge of the experiments in animal nutrition.

PROFESSOR E. W. MACBRIDE, F.R.S., has been appointed successor to the late Professor Adam Sedgwick in the chair of zoology at the Imperial College of Science, South Kensington.

DR. ALEXANDER TORNQUIST, of Königsberg, has been appointed professor of geology at Leipzig.

DISCUSSION AND CORRESPONDENCE

THE PELYCOSAURIAN MANDIBLE

Ten years ago I figured and described a peculiar bone in the plesiosaurian mandible, lying along the teeth on the inner side and meeting its mate in the symphysis. It was in form and position so totally unlike the coronoid bone of other reptiles that I hesitated long before calling it that. Within the past few years, however, Dr. Andrews has recognized the same bone in certain European plesiosaurs, and its identity seems assured.

Some time ago I made out with considerable confidence a similar structure in the mandible of *Dimetrodon,* from the Permian of Texas, but, in the absence of corroborative proof, I have waited till an abundance of material has confirmed beyond dispute the presence of a bone in the mandible lying along the teeth and reaching nearly to the symphysis. It is narrow and rather loosely attached to the dentary, so much so that it is usually macerated away and lost. It lies along the alveolar border, beginning in an acute point opposite the middle of the third tooth, and extends apparently quite to the end of the tooth series. For most of its extent it is bordered below by the splenial, which diverges from it in front opposite the posterior end of the symphysis to enclose a V-shaped tongue of the dentary. It lies closely applied to the bases of the teeth, covering over the alveolar pits for the growth of new teeth. It apparently ends below the last tooth by a narrow end, but it is not improbable that it is very narrowly continuous with the true coronoid, and if so is quite identical with the structure in the plesiosaurs. The true coronoid lies at the summit of the coronoid eminence, extending about two inches back of the teeth. It is covered on the outer side by the dentary, and is inserted in a pit in the surangular; it is usually lost in specimens of *Dimetrodon.* If it is continuous with the alveolar bone, as it seems to be, the connection must be very narrow. I doubt not that it is homologous with the bone called epicoronoid by Watson in the Stegocephalia, even as the alveolar bone is homologous with his so-called coronoid.

The splenial, hitherto undescribed in the Pelycosauria, is a large element lying along the lower side of the mandible, visible from the outer side and entering extensively into the symphysis. As I have previously stated, and as reaffirmed by Watson, this symphysial union of the splenial is characteristic of all primitive reptiles, and evidently also, of all primitive amphibians. To nearly as far as its middle the splenial is bordered above on the inner side by the alveolar bone already described. Back of its middle it is separated from that bone by the slender prolongation of the prearticular, precisely as in the plesiosaurs.

This resemblance of the structure of the mandible in the pelycosaurs with that of the plesiosaurs has an important bearing on any theory of the phylogeny of the latter group. They could not have originated from any forms in which the coronoid had been reduced to the condition in all modern reptiles.

Full descriptions and figures of the mandible, not only of *Dimetrodon,* but also of various other Permian reptiles and amphibians will be published within a year.

S. W. Williston

University of Chicago,
August 25, 1913

THE DISTANCE HOUSE FLIES, BLUE BOTTLES AND STABLE FLIES MAY TRAVEL OVER WATER

Little evidence exists as to how far stable and blue bottle flies ordinarily travel to or from their feeding and breeding places. House flies, it is claimed, seldom stray over 500 yards from their breeding places; but some English observations prove that they may go over a mile from an infested dump to the nearest village.

In connection with the Cleveland Anti Fly Campaign, urgent requests were sent in to Dr. Jean Dawson for some means of relief from the plague of flies on the cribs of the water works, situated a mile and a quarter, five miles and six miles out in Lake Erie north of the city. Being in Cleveland for a

few days, at the request of Dr. Dawson and Mr. Vandusen, of the water works department, I visited the three cribs. The department launch left the harbor about ten o'clock of the morning of August 21, steaming directly to the nearest crib, a mile and a quarter out. Two house flies came out with the launch. A light breeze was blowing from the south, possibly six to eight miles an hour, and it carried the intensely acrid, sulphurous smoke of the city out over the lake. For nearly a mile out this smoke was so strong that it made my eyes smart and run tears, and quite possibly this low sheet of smoke may have had something to do with driving the flies out of the harbor. I found this first crib swarming with flies. In a lot caught at random I counted 41 house flies, 9 stable flies and 4 blue bottles.

From this crib we steamed out to the six-mile crib. Here the flies were even more numerous than on the first crib or even anywhere about the docks. My catch here was 10 house flies, 22 stable flies and 1 blue bottle. Possibly twenty stable flies followed us into the launch and over to the five-mile crib. My catch here was from a trap baited with sugar and water with a few drops of vinegar added: 4 house flies, 25 stable flies and 12 blue bottles.

Two crib tenders live on each crib, but there are no animals and there is absolutely nothing in which flies of any kind could breed. All garbage and waste matters are dumped immediately into the lake or are put into a tight incinerator and burned daily. Lake steamers pass within about half a mile of the cribs, but none of the men had ever noticed any evidence of flies coming from them. All the crib tenders maintain that a south wind brings a cloud of flies from the city and that a north wind carries them away. No smaller boats were anywhere near the cribs that day and seldom come near them.

The only explanation for the above facts seems to be that the flies are blown at least six miles off shore, and that they gather on the cribs as temporary resting places. Attraction of any other sort can not be a strong factor: else they would remain on shore, attracted by the animals and men along the docks and the much richer food supply. While not entirely conclusive, the evidence seems strongly to support the theory that flies of the above kinds are able to travel much farther than is commonly supposed.

All the flies in the crib appeared to be ravenously hungry and it will not be difficult to trap the house and blue bottle flies as fast as they come. The stable flies bite most viciously, but they, too, enter the traps in numbers, and it is quite probable that all the flies on the cribs can be killed most easily with formalin bottles, 2.5 per cent. in a milk or beer or sugar and vinegar mixture, whichever may prove most attractive to them.

C. F. Hodge

THE WORD "FUNGUS"

To the Editor of Science: He is a brave man who openly throws stones at another man's domicile, even if he justify the act as altruistic, knowing the proverbial danger incurred. Certainly he should not be surprised by some return.

In Science of September 5 Dr. Dabney has justly taken exception to the use of the common expression "quite a few." But he has erred in calling it "slangy," "a malevolent fungus growth," or "a sort of fad." It is simply a colloquial term in certain parts of the country, and occasionally slips into dignified writing, as do other indefensible phrases. But they are not becoming established, as Dr. Dabney implies; the tendency is quite the reverse. When all scientific men shall have been recruited from the ranks of the learned, such unpleasant evidences of the survival of youthful derelictions of speech will have disappeared.

Having taken notice of Dr. Dabney's fling, I offer one in return. One must be doubly surprised to notice that in a criticism of a colleague regarding "good English," there occurs a lapse in "good grammar." What justification is there for the usage "fungus growth?" Possibly the phraseology is in recognition of the increasing demand for hyphenated substantives, with the hyphen dropped out. Or

the adjective *fungous* may have been intended, with the *o* accidentally omitted. Or could it be that the much abused word *fungoid* would have met the author's requirement? The use of words from the sciences demands caution from the general writer, but in a scientific journal there should be no lapse, certainly none from the pen of a critic. The word *fungus* with its derivatives is too often misused.

J. C. Arthur

Purdue University,
Lafayette, Ind.

QUOTATIONS

THE AMERICAN UNIVERSITY FROM TWO POINTS OF VIEW

The finest thing which civilization has yet produced is a great American university upon a private foundation. A company of gentlemen associate themselves and assume the obligation of providing the means for, and the organization of, an institution for the highest culture, not only without any pecuniary compensation to themselves, but giving freely of their time, effort and substance, and securing, in their aid, the countenance and contributions of their friends and fellow citizens, and a body of scholars, selected by this original association, who, sacrificing at the outset the prospect of worldly gain, devote themselves zealously and enthusiastically to the discovery of truth and its dissemination and to the making of character—such, in brief outline, is this great product of human evolution. No other nation on the earth has brought the like of it forth. It is the peculiar offspring of American conscience and American liberty. To have had an honorable part in the creation of such an institution is a privilege of the highest order and obligates the happy participant to render to his fellowmen an account of his experiences.—Dean John W. Burgess in the *Columbia University Quarterly* for September.

In America there are three sexes—men, women and professors. It is the saying of European scholars looking from those self-governing democracies, their universities, upon ours. They see ours ruled without the consent of the governed through presidential autocrats by boards of non-scholar trustees—not a part of the world of learning, but superimposed upon it. The American professor has the status of an employee subject to dismissal without trial by men not his colleagues.

The universities of Germany, the older universities of England and Scotland respect and trust and leave free the individual. Their organization gives them the right to regard themselves as provinces of the republic of letters. The overlorded universities of America have no such right.

For a couple of centuries American professors have submitted to a system which gives most of them little control over their own lives, small power to defend any truth which has powerful enemies, no part in shaping the policies of the institutions in which they teach. Hence the pitiable figure of the American scholar to whom Emerson, Emersonically oblivious of such little matters as despotic college government, held up a high ideal of independent manhood.

The position of her scholars under the thumb of business men and capitalists who control the university purse is enough to account for the fact that America is intellectually second rate. Unless content to remain so Americans have got to think down to bedrock about university government and do what thought demands.

Feeling that something is wrong, we have begun to examine the life of our universities, but no general attention has centered as yet upon their inherited, undemocratic system of control which is bearing the fruit of timidity and subservience among those twenty-three thousand men and five thousand women whose social function is to create and transmit American thought.—George Cram in the *Forum* for October.

SCIENTIFIC BOOKS

Determination of Time, Longitude, Latitude and Azimuth. Fifth Edition. By William Bowie. Special Publication No. 14, U. S.

Coast and Geodetic Survey. Washington, Government Printing Office. 1913.

It is the purpose of the reviewer to discuss Parts I. and II. only—the parts relating to the determination of time and longitude.

The reason for the appearance of the volume is twofold: first, the fourth edition, by Professor John F. Hayford, at the time inspector of geodetic work, has become exhausted; and secondly, so much that is new has developed in the interim, and so much of the old has become changed or entirely discarded, that it has been thought advisable, even though much of the old material may be found scattered through other publications, to issue still another volume, one which shall be in itself complete and thoroughly accordant with present practise. So great is the demand for this valuable manual that the new edition has already nearly given out, and it has consequently been found necessary to order the printing of an additional thousand copies.

The self-registering transit micrometer, introduced by Repsold a quarter century ago, and the principle soon after adopted in Europe of reversing the transit instrument during the observation of each star, have almost revolutionized the methods of longitude determinations. Their advantage is that they afford additional strides forward in the direction of eliminating constant and systematic errors by skilful observational manipulation rather than by applying corrections in the course of the computation. Reversal during the transit of each star eliminates collimation, inequality of pivots, irregularity and other errors of the transit micrometer screw (or, if a fixed reticle be employed, the thread intervals), and, in the case of the broken-back telescope, bisection error and flexure. With regard to the micrometer, though claim has been made that its use leads to a higher degree of precision, its chief value lies in that it almost annihilates the observer's personal equation. As the instrumental and personal equations are thus so greatly reduced, further approach is rendered possible towards the ideal arrangement of reducing the observational errors exclusively to the accidental type. These two innovations have accordingly been attended with so great success that, employed originally in the field, they have found their way even into the fixed observatory.

There the right-ascension micrometer has come to stay. Whether the ponderable telescopes of the fixed observatory can be adapted to quick reversal, however, remains yet to be seen. At Kiel and at Bergedorf they are employing transit circles designed and built with this purpose in view, but the onlooker during the operation of reversal instinctively fears for the safety of the instrument. Experiments are still under way. Speedy reversal with the portable transit, on the other hand, was long ago effected by both the Germans and the French, the latter developing the straight telescope with diagonal eye-piece, the former the broken back.

Ever alert as the Coast and Geodetic Survey authorities are for any device bearing the impress of improvement, they have stamped their mark of approval upon both these innovations. Though they have not purchased or made any astronomic instruments for time observations since the appearance of the fourth edition of their manual, they have recently ordered two telescopes of the broken type, reversible on each star, such as have "been used with marked success by other countries," and illustrated in Plate 2. The right-ascension micrometer they welcomed a decade back. Skilfully designed by the chief of the instrument division, Mr. E. G. Fischer, and tested in a thorough experimental and theoretical investigation by Professor Hayford,[1] the micrometer has since proved of such worth that the effect of its introduction may be traced throughout the new edition.

When the chronographic method of star registration was introduced in the middle of the last century—and it will be recalled what a prominent part the Coast Survey played in the introduction—astronomers fondly hoped to eliminate by its means that most troublesome of "constant" errors, personal equation. That it greatly reduced the magnitude of this

[1] Appendix No. 8, Report of the Superintendent for 1904, "A Test of a Transit Micrometer."

equation as obtained by the method of the eye and ear is well established. The same fond hopes lay at the basis of introducing the "impersonal" micrometer; and again there has been a great reduction in personal equation. The evidence in favor of annihilation, however, is inconclusive. Though many astronomers have succeeded in reducing the equation to practically within the limits of accidental error, and some have made so bold as to affirm that the equation has entirely disappeared, there yet remain other astronomers who have not been able to verify these conclusions—witness the experiences at Ottawa. As likely as not, history will repeat itself.

Even if personal equation has not been annihilated, nevertheless, astronomers now possess an advantage that formerly was not theirs; and that is, that with present facilities it is possible entirely to dissipate the effect of personal equation in longitude determinations. For the *variation* of personal equation, generally conceded to be the chief source of longitude error, may, now that the personal equation itself has become so much lessened, be looked upon as lessened to a corresponding degree, which makes it negligible; and the small residual amount of personal equation left in the observations by the right-ascension micrometer may be made to disappear through exchange of observers.

It is only in the finest class of longitude work that the precaution of exchanging observers is deemed necessary. For ordinary geodetic purposes, since personal equation has become so small as to be termed negligible, this precaution is believed to be needless. The introduction of the transit micrometer has consequently led to radical changes in the methods and program of survey longitude operations. "The program of longitude observations was formerly designed to eliminate the personal equation" (p. 79); and variation of personal equation is a bugbear no longer to be feared. The influence on the time and expense connected with longitude work (p. 94) may be estimated from the fact that it has been found possible, in accordance with Professor Hayford's prediction of 1904, without loss of accuracy, to reduce the original program of ten nights' observing to three or four. It should be noted, however, that even with the method of the key, "a reduction of the number of nights per station to six, or even four, would result in but slight decrease in accuracy" (p. 94).

Before leaving the topic of personal equation it may be well to call attention to another form of this equation, the bisection error. On page 90 the writer believes that for ordinary geodetic purposes this is too small to be considered. This may or may not be true; and it may make a difference whether a single or a double thread be employed. Contradictory evidence may be found in "A Test of a Transit Micrometer," above cited (p. 472), and "Report of the Chief Astronomer," Ottawa, 1909 (pp. 576 et seq.). By reversal during the transit of each star, as already mentioned, the bisection error is automatically eliminated from observations made with the broken-back telescope. With the straight telescope, this elimination may be effected, not from each individual star, but from the clock correction, by a suitable selection of stars north and south of the zenith.

Returning to the survey observing program, another innovation involves the sets of stars comprising a time determination for longitude. The former custom of requiring generally four half-sets is still retained; but the nature of the sets is greatly changed. Where formerly it was customary to observe four clock stars and one azimuth star to each half-set, the clock stars chosen with balanced A factors, the practise now is to eliminate the azimuth star entirely, and to replace it by two additional clock stars. As the interval of time required to observe each star is less than by the method of the key, the total time employed is not greater than before. The argument is, that as the azimuth of the instrument, owing to the balancing of the A factors, has but little effect upon the resulting time determination, it is preferable, rather than to attempt determining this azimuth accurately with an azimuth star, to strengthen the clock correction by observing additional time stars. For

a discussion of this topic see the fourth edition, p. 295.

At latitudes higher than 50°, where it is impracticable to obtain sufficiently slowly moving zenith stars with balanced *A* factors, and where, consequently, the error in azimuth will materially affect the clock correction, the older method of observing an azimuth star is still employed. The number of stars in each half-set, however, following perhaps the practise of the Germans, is increased to six. It is a fair question, in this connection, whether this ratio of azimuth to clock stars is sufficiently large.

The time sets are so chosen, and the reversals of the instrument between half-sets so planned, as to eliminate collimation and inequality of the pivots (p. 19). Inequality and irregularity of the pivots, indeed, as the pivots have been reground and tested (p. 46), and owing to the plan of observing adopted (p. 50), is thought negligible. This is in contrast to the practise formerly in vogue. As for the collimation, if it may be depended upon to remain constant during a time set, it will be eliminated entirely. With instruments reversible on each star, as already noted, inequality of pivots and collimation are rigorously eliminated automatically by the reversal. Instead of depending upon the invariability of the instrumental constants for an hour, this dependence is necessary for but a few moments—a decided advantage. On the other hand, the possibility exists that too frequent reversal may disturb the azimuth; and as the disturbance is likely to occur between the two parts of each star observation, this is a serious matter. The French have accordingly introduced the practise of reading at sufficiently frequent intervals on a meridian mark.

It should be noted, too (p. 27), that among other advantages, reversal on each star leads to simplified computation.

"It is desirable, but not necessary" (pp. 43 and 80, sec. 4), is the comment on the requirement of the previous edition that the same stars, wherever possible, be observed at both stations of a longitude determination. It is now believed that errors of the star places are smaller than those introduced by the instrumental constants; or by the variation of those constants due to extending the observations over too long an interval; or by poor balancing of the *A* factors; or by an unwise choice of epoch for exchange of clock comparison signals (pp. 87 and 93, sec. 7). The argument upon which this reasoning is based is not conclusive; for the accidental errors of the star positions alone are taken into account, nothing being said of those classed as systematic. Yet it is probably true that great inaccuracy will not result, especially if a large proportion of the stars be observed in common at the two stations.

Not only is the publication marked by the adaptation of a new device to the old instrument, and the adoption of a new program of observing, but also by a new method of reducing the observations. The germs of this method may be found in the old edition, p. 296. The use of least squares has for the most part been done away with; the refinement, evidently, is believed to be unwarranted by the observed data. The result is a more direct and easy method of solution. To simplify the computations further, unsymmetrical threads are usually rejected (pp. 24, 79 and 80). Criteria for the rejection of other threads are laid down on p. 80. Corrections for rate (p. 24) are generally regarded as unnecessary refinement. Contrary to former practise, all stars observed at latitudes under 50° are weighted equally (pp. 79 and 80), and weights generally are taboo (p. 89).

The survey is quick to take advantage of any opportunity. When the International Geodetic Association commenced furnishing corrections for reducing the observed to the mean position of the pole, the survey began to make use of these corrections. When the *American Ephemeris and Nautical Almanac* became enabled, through the omission of the lunar distance tables, to extend its list of stars, the survey, probably having in mind also the greater ease of interpolation from the Washington meridian, assigned to that ephemeris the preference formerly held by the *Berliner Jahrbuch* (pp. 25 and 43); and from

considerations of economy it put a stop to the practise formerly permitted of computing apparent places. When, from the same cause, the *American Ephemeris* found room between its covers for tables of Polaris facilitating azimuth determinations, the survey was quick to take advantage also of these tables (p. 17).

With regard to Mr. Duvall's ingenious device for the graphical determination of the *A, B, C* factors of Mayer's formula, it may be stated that this is not the first time such a device has been put forward. Plate XII., Astronomical Observations of the U. S. Naval Observatory, Washington, 1846, with description on pp. xliv et seq., illustrates a similar solution of the same problem by Bessel's formula, the chart being adapted to the determination of $m + n \tan \delta$, and also, with the aid of an auxiliary table, of $c \sec \delta$.

The difficulty encountered in the footnote on p. 270 of the former edition has been neatly surmounted in the new.

Another novel feature is the inclusion of a treatise on time determinations with the vertical circle. It would not be surprising to find the next edition include also an account of the astrolabe. Recently developed by the French, and claimed by them to give results comparable with those obtained by the portable transit, this instrument has much to commend it. It is as portable as a theodolite, requires no firm-set pier, is easily manipulated, and the same observations employed for time may be used also for latitude.[3] On the other hand, the computations, both preliminary to and following the observations, are heavy; and the most serious obstacle encountered with this instrument, if all accounts are to be believed, would seem to be that old and familiar stumbling-block, personal equation.

From a literary standpoint the new edition is markedly improved. Where in the older volume the diction was awkward, it has here been replaced by wording more smooth and elegant. Here and there a sentence has been altered for clearness, or a phrase added to supply an idea previously left to the fruitful imagination of the reader. Where a paragraph or a sentence was superfluous, it has here been omitted. The numbering of the sections has been done away with, and more headings have been supplied for sections which properly should appear as such. It can not be said, on the other hand, that the change from words to figures when referring to numerals is a decided literary advantage; nor that all omissions have been improvements. On p. 23, for example, there might have been retained in its proper place the remark on p. 281 of the former edition, "For a discussion of this matter, see —." Among minor changes may be noted slight modifications of notation to prevent confusion, and the substitution of numerals for asterisks and daggers. The continuity is broken by continual switching from discussion of methods with the transit micrometer to those with the key, but to offset this the book is of increased value as a more complete manual.

Of the various methods for determining longitude, the ordinary telegraphic and the chronometric are treated fully. Lunar and other methods less frequently employed in the survey are merely mentioned on p. 78. Determinations by wireless telegraphy, though already employed in Europe and by the American Navy are still in the experimental stage. This will without doubt be the method of the future, and the proposed determination of the difference of longitude between the U. S. Naval Observatory and the Observatory of Paris, as well as a similar trans-Atlantic scheme under contemplation by the survey authorities for the near future, should aid greatly in the development of this method.

The publication is highly creditable to the officers of the Coast and Geodetic Survey, and the reviser and part author is to be congratulated upon maintaining so well the high standard set by his predecessors, Schott and Hayford.

DAVID RINES

[3] See Chauvenet's "Spherical Astronomy," Vol. I., p. 280, and Claude et Driencourt's "L'Astrolabe à Prisme."

The Climate and Weather of San Diego, California. By FORD A. CARPENTER, LL.D.,

Local Forecaster, United States Weather Bureau. San Diego Chamber of Commerce. 1913. Pp. xii + 118.

That a chamber of commence thinks it advisable to publish such a volume as this speaks well for the city represented. The book bears little resemblance to the ordinary "boom literature" of pushing cities, with which we are too familiar.

The book is distinctly readable and interesting. The weather phenomena of the southern California region are treated in a somewhat popular, but thoroughly scientific manner. The elements, which make up the complex called climate, are considered separately; both the conditions more or less peculiar to the region and those of more widespread occurrence are considered from the standpoint of their causes. The climate of San Diego, from the records of the Weather Bureau and its predecessor, the Signal Service, is shown by the usual tables of data and is also described in words. The record is uninterrupted from its beginning, July 1, 1849, when meteorological work was established in San Diego as a part of the duties of the post surgeon of the army; therefore the data form one of the longest records in the United States. The book is well illustrated with photographs of the region and the meteorological instruments, as well as with maps and diagrams.

This volume may well serve not only as a sample of the kind of thing which can and ought to be done by a progressive chamber of commerce or similar organization in a region climatically favored, but it is also well suited as an introduction to the whole subject of meteorology and should give a better understanding to the processes which control the weather. Both Dr. Carpenter and the city of San Diego are to be congratulated on the appearance of this volume. It is to be hoped that as interesting and accurate discussions of the climates of particular places will become the rule, instead of the exception as at present.

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NOTES ON METEOROLOGY AND CLIMATOLOGY

INTERNATIONAL METEOROLOGY

THE report of the secretary (Dr. G. Hellmann) of the meeting of the International Meteorological Committee (composed, in general, of the directors of national weather services), held in Rome, April 7–12, 1913, has recently appeared.[1]

Assistance on the question of the influence of weather on agriculture having been asked by the president of the International Institute of Agriculture, the Meteorological Committee responded by appointing a permanent commission consisting of Messrs. Angot, Börnstein, Brounow, Louis Dop, Hergesell, Palazzo and Stupart.

The recommendations of the Commission on Weather Telegraphy, which met in London in September, 1912, were adopted with but few changes. Thus on May 1, 1914, the long-desired, uniform telegraphic code throughout Europe will come into use.

The report drawn up by Messrs. Palazzo, Köppen and Lempfert showed that the mean wind velocities equivalent to the numbers of the Beaufort scale of wind force in use in different countries are widely variant. The Meteorological Committee asked for a further investigation, to consider gusts of wind as well as mean velocities for the force equivalents of the 10- or 12-point Beaufort scale.

The proposal of the International Committee for Scientific Aeronautics to have international cooperation in upper-air observations in many parts of the Arctic in 1915, during Captain Amundsen's polar expedition, was warmly supported and a small subcommittee consisting of Messrs. Hergesell, Rykatchew, Ryder and Stupart was appointed to deal with the question.

To have aerological data in convenient form for the purposes of dynamic meteorology, Professor V. Bjerknes, of Leipzig, at the meeting

[1] "Bericht über die Versammlung des internationalen meteorologischen Komitees Rom 1913," No. 260, Veröffentlichungen des Kgl. Preuss. Met. Inst. Berlin. See also *Nature*, London, Vol. 91, p. 198.

of the International Commission for Scientific Aeronautics in Vienna, May 27–June 1, 1912,[2] proposed (1) that the results of upper-air observations shall be arranged according to definite steps of pressure instead of steps of height; (2) that the heights shall be given in "dynamic meters," *i. e.*, a step corresponding with a certain difference of gravity potential, not of geometric height; (3) that pressures shall be recorded in millibars (C.G.S. units), instead of in millimeters or inches. There was so much objection against a change of units, that the Meteorological Committee resolved that, for the present at least, aerological pressure results should be published both in millimeters and in millibars. The substitution of pressure steps for linear steps was favorably passed upon, but the proposition as to "dynamic meters" was referred back to the commission at the request of its president, Dr. Hergesell, for further consideration.

On the recommendation of the radiation commission, it was resolved that specifications as to sunshine recorders be drawn up, to facilitate comparison between sunshine records in different countries.

The resolution of the Paris conference (1896), calling for the standardization of thermometer exposure, was discussed and tests of English thermometer shelters in the tropics were recommended.

A system of signals for international use was recommended by the Commission on Maritime Meteorology and Storm-warning Signals, and accepted by the Meteorological Committee with a few minor changes. Thus a substantial measure of international agreement on day and night storm-warning signals has been attained.

The next conference of the committee will come in 1915, in Holland.

EVAPORATION FROM LAKE SURFACES

In the *Meteorologische Zeitschrift* for May, 1913, Dr. J. Maurer, director of the Swiss Weather Service, gives the results of his measurements of evaporation from the surfaces of Lakes Zuger and Ägeri in northern Switzerland, December, 1911–November, 1912, inclusive. By the method used, the evaporation is the difference between the amount of water entering a lake and that flowing out, if the water-surface level remains constant. The amount entering in streams was determined as closely as possible by frequent measurements of the cross-sections and velocities of the streams flowing into the two lakes. To these the amounts of rainfall on the lake surfaces were added. The water flowing through the outlet streams was also carefully measured. With the aid of measurements of the variations in height of the lake surface as indicated on gauges for the purpose, the results from the other measurements could be checked to some extent. The totals of monthly evaporation are probably correct within 0.5 cm. The unknown amount of gain or loss of water through the lake bottom was disregarded, for, on the whole, these lakes have impervious basins and no large springs are known. Supplementary observations of the temperature of the water surface, humidity at the water surface, and of the air-temperature, wind, cloudiness, etc., were taken at selected points. In 1912, a year with a cool and rainy August and September, the measurements showed an evaporation of 775 mm. from Zuger Lake (417 m. above sea level, area 34 sq. km.) and 740 mm. from Ägeri Lake (727 m. above sea level, area 7 sq. km.). In a year with a normal summer, the annual evaporation would probably exceed 900 mm. These interesting results are the first of their kind yet published, and bid fair to lead the way for other similar measurements on lakes and reservoirs elsewhere.

VOLCANOES AND CLIMATE

The solar radiation observations of Messrs. C. G. Abbot and F. E. Fowle[3] and Professor H. H. Kimball[4] show that the Katmai volcanic dust cloud in the atmosphere in the summer of 1912 in the northern hemisphere, so increased diffuse reflection into space and absorption of heat in the upper atmosphere, that the normal

[2] See *Nature*, London, Vol. 90, p. 110.

[3] "Volcanoes and Climate," Smithsonian Misc. Coll., Vol. 60, No. 29.

[4] *Mt. Weather Bull.*, Vol. V., Part 5.

amount of solar radiation received at the earth's surface was decreased by about 10 per cent. Observations of terrestrial radiation made at the same time by Mr. A. K. Ångström, showed that the presence of the dust likewise hindered terrestrial radiation, but not to such an extent as the solar radiation (of shorter wave-length). The net result of these opposite tendencies, however, seems to have been a decrease of heat available to warm the lower atmospheres. Temperature observations of high-level stations in Europe and America bear this out, showing a marked decrease of temperature with the beginning of the volcanic dust cloud at the end of June.

Other periods of marked decrease in the solar radiation received as observed during the last thirty years were the period 1883–1885 following the Krakatoa eruption; 1888–1894 after the great eruptions of Bandai-San, Mayon and other volcanoes; and the period 1902–1904 following the tremendous eruptions of Santa Maria and Colima.

In comparing Abbot's and Fowle's composite curve of Wolfer's sunspot numbers and Kimball's solar-radiation departures, with the mean departures of maximum temperature of 15 stations in the United States, it is interesting to note that the temperature effects of these dust-haze periods seem to explain the discrepancies in the apparent synchronism between terrestrial temperatures and the 11-year sun-spot period.

In an extra number of the *Bulletin of the Mount Weather Observatory*,[5] Professor W. J. Humphreys has discussed at length the subject "Volcanic Dust and Other Factors in the Production of Climatic Changes, and Their Possible Relation to Ice Ages." Particular attention is given to sun-spots and great volcanic eruptions as related to variations in temperature at the earth's surface since 1750. The phase of this subject concerning geological changes of climate is treated by the same author in the *Scientific American* Supplement, August 23, 1913, p. 114.

CHARLES F. BROOKS

BLUE HILL METEOROLOGICAL OBSERVATORY

[5] Vol. VI., Part 1, 34 pp.

DEGREES CONFERRED BY THE UNIVERSITY OF BIRMINGHAM

AT the Birmingham meeting of the British Association the university of the city conferred, as has already been noted here, the degree of doctor of laws on several of the foreign guests. In introducing them Sir Oliver Lodge, president of the association and principal of the university, spoke as follows:

DR. ARRHENIUS: Director of the Nobel Institute for Physics and Chemistry, at Stockholm, fellow of the Swedish Academy of Sciences, and foreign member of our own Royal Society. The courageous way in which Dr. Arrhenius applied the theory of electrolytic dissociation to a quantitative study of chemical reactions has profoundly modified the trend of chemical science during the past thirty years, enlarging the scope of chemical investigation, harmonizing previously disconnected facts, and bringing an ever-increasing number of chemical phenomena within the range of quantitative and mathematical treatment. He is thus one of the most prominent of the founders of modern physical chemistry, the principles of which he has even applied, with singular success, to some of the most subtle phenomena of organic life. Recently his writings on cosmogony have aroused wide interest; terrestrial electricity and the aurora have yielded to him some of their secrets; and his speculations on worlds in the making are more than interesting and suggestive. A man of genius, and one of the founders of physical chemistry, I present for the honorary degree of doctor of laws, Svante August Arrhenius.

MADAME CURIE: The discoverer of radium, director of the Physical Laboratory at the Sorbonne, and member of the Imperial Academy of Sciences at Cracow. All the world knows how Madame Curie (coming from Warsaw as Marie Sklodowska to work in Paris), inspired by the spontaneous radioactivity newly discovered by Becquerel, began in 1896 a metrical examination of the radioactivity of minerals of all kinds; and how, when a uranium residue showed a value larger than could have been expected from its uranium content, she, with exemplary skill and perseverance, worked down some tons of this

material (given her by the Austrian government on the instigation of Professor Suess), chemically dividing it and retaining always the more radio-active portion, until she obtained evidence first of a new element which she christened polonium, in memory of her own country, and then after months of labor succeeded in isolating a few grains of the other and more permanent substance now so famous —a substance which not only exhibits physical energy in a new form, but is likely to be of service to suffering humanity. Of the metallic base of this substance she determined the atomic weight, finding a place for it in Mendeléeff's series; and with the aid of her husband, whose lamentable death was so great a blow to science, she proceeded to discover many of its singular properties, some of them so extraordinary as to rivet the attention of the world. Subsequent workers engaged in the determination of numbers belonging to either of her special elements, radium and polonium, have sought her advice, and it has proved of the utmost value. I have now the honor of presenting for our honorary degree the greatest woman of science of all time, Marie Sklodowska Curie.

Professor Keibel: The professor of anatomy in the University of Freiburg is the leading authority on the development of man and the embryology of vertebrates. He originated the international standards used in estimating embryological data, and through his classical work on comparative development he has reformed anatomical teaching by the infusion of developmental ideas. His important contributions to anatomical knowledge and method are widely known and highly esteemed, but nowhere more heartily and cordially than in the anatomical department of this university. Held in affectionate esteem by his colleagues, and directing one of the largest schools of anatomy in Germany, this eminent embryologist has been invited to receive our honorary degree, and I present to you Franz Karl Julius Keibel.

Professor H. A. Lorentz: To the great school of mathematical physicists of the last and present centuries we in England have proudly contributed even more than our share; but we recognize in the professor of physics in the University of Leyden a contemporary worker worthy to rank with our greatest. Professor Lorentz has extended the work of Clerk Maxwell into the recently explored region of electrons, and has developed in the molecular direction the Maxwellian theory of electrodynamics. He is a chief authority on the behavior of material bodies moving through the ether of space, and he has adopted and reduced to order many of the progeny resulting from the fertile marriage of electricity and light. A specially interesting magneto-optic phenomenon, experimentally discovered by his countryman, Zeeman, of Amsterdam, received at his hands its brilliant and satisfying interpretation; an interpretation clinched by predictions of what, on the electric theory of radiation, ought additionally to be observed—predictions which were speedily verified. The Zeeman phenomenon thus interpreted not only gives information as to the intimate structure of various elemental atoms, but, in the hands of the great American astronomers, has shown that sun-spots are electric cyclones of high magnetic power, and is likely further to contribute to our knowledge of solar and stellar constitution. As a great authority on electron theory, and one whose name will forever be associated with the now nascent electrical theory of matter, I present to you the distinguished mathematical physicist, Hendrik Antoon Lorentz.

Professor R. W. Wood: The professor of experimental physics in the John Hopkins University of Baltimore is a prolific experimentalist, and one to whose researches in physical optics modern science is greatly indebted. By ingenious use of little-known properties of light, he has explored the structure of molecules, applying the principle of resonance to determine their natural electronic period of vibration. He has, in fact, discovered a new type of spectra in the fluorescent resonance of metallic vapors. What more he has done, in connection with the anomalous absorption of sodium vapor with specially designed diffraction gratings, and with the application of monochromatic photography to the geology of the moon, it were long to tell; among other

things, he anticipated and realized the attainment of regular reflection from a sufficiently dense absorbing vapor; while to the public in America he is known as the inventor of a practical method of thawing frozen pipes by an electric current. The idea of a gigantic telescope in the form of a sunk well, with a revolving pool of mercury at its base to constitute a truly parabolic mirror, may not be a new one, but Professor Wood has taken it out of the region of the chimerical and shown that it is possible, even if not practically useful. We in this country have reason to envy the splendid resources which the munificence of citizens in America, and of governments elsewhere, places at the disposal of scientific explorers, and we honor and admire the use which is being made of those resources in every branch of science. As one of the most brilliant experimental physicists of the world, I present for our honorary degree Robert Williams Wood.

THE NEW INTERNATIONAL DIAMOND CARAT OF 200 MILLIGRAMS

The importance of having uniform weights, and the great practical disadvantages resulting from the international use of a perplexing variety of standards, have long made themselves felt in the diamond market. This subject has just been very fully treated in a paper read before the American Institute of Mining Engineers, at the New York meeting, February, 1913, and at the Butte meeting, August, 1913.[1]

Those unfamiliar with the system of weights employed by diamond-dealers can scarcely appreciate the confusion that has existed, and the necessity for complicated calculations thereby entailed. This state of things will be best illustrated by giving here the equivalents in milligrams and troy grains of the principal standard carats as used in various trade centers:

[1] "The New International Metric Diamond Carat of 200 Milligrams (Adopted July 1, 1913, in the United States)," by George Frederick Kunz, New York, N. Y., author's edition, 21 pp. (pp. 1225–1245 of the *Trans. of the Soc. of Min. Eng.*).

	Milligrams	Grains Troy
Turin	213.5	3.29480
Persia	209.5	2.23307
Venice	207.1	3.19603
Austro-Hungary	206.1	3.18060
France (old)	205.9	3.17752
France (later)	205.5	3.17135
France (modern)	205.0	3.16363
Portugal	205.8	3.17597
Frankfort and Hamburg	205.8	3.17597
Germany	205.5	3.17135
East Indies	205.5	3.17135
England and Brit. India	205.3	3.16826
Belgium (Antwerp)	205.3	3.16826
Russia	205.1	3.16517
Holland	205.1	3.16517
Turkey	200.5	3.09418
Spain	199.9	3.08492
Java and Borneo	196.9	3.03862
Florence	196.5	3.03245
Arabia	194.4	3.00004
Brazil	192.2	2.96610
Egypt	191.7	2.95838
Bologna	188.6	2.91054
Internat. Carat, year 1875	205.0	3.16363
New International Carat	200.0	3.08647

A glance over this table will serve to show the crying need for the establishment of a uniform and rational standard, and a preliminary step in this direction was taken by the Parisian jewelers in 1877, when they adopted a carat of exactly 205 milligrams. However, such a carat could never become an integral part of the metric system, and as early as 1893 the writer suggested in a paper read at Chicago before the International Congress of Weights and Measures, held in connection with the World's Columbian Exposition, that a carat of exactly 200 milligrams should be recognized as the standard carat weight. Many years, however, elapsed before there was any definite prospect that this idea would be realized. The fact that in the early part of 1905 the German imperial government refused to recognize the carat then used in Germany as a standard weight, when requested so to do by the German Federation of Jewelers, because such recognition would be a violation of the laws prescribing the exclusive use of the metric system, is said to have powerfully

stimulated French endeavors for the reform of the carat by bringing it within the scope of the metric system.

The most effective worker in this direction was M. C. E. Guillaume, director of the Bureau International des Poids et Mesures at Sèvres, who urged the adoption of a carat of 200 milligrams before the International Congress in April, 1905. In January of the succeeding year, the Chambre Syndicale de la Bijouterie, Joaillerie et Orfèvrerie of Paris passed a resolution favoring the adoption of the metric carat, and in August of the same year the German federation of gem-dealers and jewelers urged its general adoption. The movement thus initiated soon spread, and by 1908 Spain had given the new carat a definite legal status, to be followed in 1909 by Japan and Switzerland. The adhesion of Italy, Bulgaria, Denmark and Norway followed in 1910, that of Holland, Portugal, Roumania and Sweden in 1911. Although it was not until 1912 that it became the legal standard in France and Germany, the law providing for its institution in the former land was passed June 22, 1909.

As in the case of all efforts to introduce metric weights or measures, the advantages of the new metric carat only very gradually became apparent in England and the United States. However, its official adoption by our Treasury Department, on July 1, 1913, as the standard for customs purposes, definitely stamps it with the seal of official acceptation here.

Belgium has already provided for the use of the new carat and England is expected to fall into line before long, so that by next year it is confidently believed there will be but one standard weight for diamonds, precious stones and pearls, the metric carat of 200 milligrams.

The paper gives a simple and easy method for converting the old carats of 205 milligrams into the new ones of 200 milligrams, and also offers many interesting details as to the history of the carat and the origin of decimal notation, the first known examples of the latter being found in a translation, published by Leonardo of Pisa in 1202, of a work by the ninth-century Arabian mathematician, Al-Khouârazmi. The first use of the decimal point is stated to occur in the arithmetic of Frances Pellos, printed at Turin in 1492.

There can be little doubt that the adoption of the metric carat in the United States will do much to favor the cause of the metric system generally in this country, as not only the thousands of jewellers but also the millions of people who buy jewelry will now learn, most of them for the first time, what a kilogram, a gram and a milligram are, when they are told that a carat equals 200 milligrams; five carats, one gram, and 5,000 carats (or 20,000 pearl grains), one kilogram.

Some additional particulars may be added from advance sheets of M. Guillaume's report to the International Conference of Weights and Measures. The Argentine Republic, Peru and Servia are all disposed to accept the new carat. In Belgium the law promulgated March 10, 1913, embraces the following article:

> In transactions concerning diamonds, pearls and precious stones, the denomination "metric carat" can be given to the weight of 200 milligrams, in derogation of articles 1 and 3 of the law of October 1, 1855.

The employment of the word "carat" to designate any other weight is prohibited.

In regard to eventual results M. Guillaume believes that the day will come when the commerce in precious stones will be confined to the employment of the ordinary metric unities; the establishment of the carat as a fiftieth part of a grain will then have constituted a stage in this definite reform, and one greatly favoring it.

George F. Kunz

SPECIAL ARTICLES

THE MECHANISM OF FERTILIZATION

In previous papers[1] I have described the secretion of a substance by the ova of the sea-

[1] Science, N. S., Vol. 36, pp. 527–530, October, 1912, and *Journ. Exp. Zool.*, Vol. 14, No. 4, pp. 515–574, May, 1913.

urchin, *Arbacia,* in sea water, which causes agglutination of the sperm of the same species. The eggs of *Nereis* also secrete a substance having a similar effect upon its sperm. I therefore named these substances sperm-isoagglutinins. During the present summer I have ascertained that in the case of *Arbacia,* and presumably also of *Nereis,* the agglutinating substance is a necessary link in the fertilization process and that it acts in the manner of an amboceptor, having one side-chain for certain receptors in the sperm and another for certain receptors in the egg. As this substance represents, presumably, a new class of substances, analogous in some respects to cytolysins, and as the term agglutinin defines only its action on sperm suspensions, I have decided to name it fertilizin.

My main purpose this summer was to study the rôle of the *Arbacia* fertilizin in the fertilization of the ovum.

1. *The Spermophile Side-chain.*—The first need in such a study was to develop a quantitative method of investigation, and this was done for *Arbacia* as follows: The agglutinative reaction of the sperm in the presence of this substance is, as noted in previous studies, reversible, and the intensity and duration of the reaction is a factor of concentration of the substance. The entire reaction is so characteristic that it was possible to arrive at a unit by noting the dilution at which the least unmistakable reaction was given. This was fixed at about a five- or six-second reaction, which is counted from the time that agglutination becomes visible under a magnification of about 40 diameters until its complete reversal. The unit is so chosen that a half dilution gives no agglutination of a fresh 1 per cent. sperm suspension. It was then found that the filtrate from a suspension of 1 part eggs left for ten minutes in 2 or 3 parts sea water would stand a dilution of from 800 to 6,400 times, depending on the proportion of ripe eggs and their condition, and still give the unit reaction. Such solutions may then be rated as 800 to 6,400 agglutinating power, and it is possible, therefore, to determine the strength of any given solution. This gives us a means of determining the rate at which eggs are producing fertilizin in sea water.

Determinations with this end in view showed that the production of fertilizin by unfertilized eggs of *Arbacia* in sea water goes on for about three days and that the quantity produced as measured by dilution tests diminishes very slowly. Such tests are made by suspending a given quantity of eggs in a measured amount of sea water in a graduated tube; the eggs are then allowed to settle and the supernatant fluid poured off and kept for testing. The same amount of fresh sea water is then added and the eggs stirred up in it, allowed to settle, the supernatant fluid poured off for testing, and so on. In one series running three days in which the quantity of eggs was originally 2 c.c. and the total volume of sea water and eggs in the tube 10 c.c., 6 to 8 c.c. being poured off at each settling, thirty-four changes were made and the agglutinating strength of the supernatant fluid diminished from 100 at first to 20 at the end. Simultaneously, with this loss of agglutinating strength, two things happen: (1) the jelly surrounding the eggs undergoes a gradual solution; (2) the power of being fertilized is gradually lost.

It is obvious that the presence of fertilizin in such considerable quantities in so long a series of washings shows either (1) that solution of the jelly liberates fertilizin, or else (2) that the eggs secrete more fertilizin each time they are washed. Both factors enter into the case inasmuch as (1) eggs killed by heat (60° C.) will stand 14 or 15 such washings, but with more rapid decline of agglutinating power than the living eggs. The jelly is gradually dissolved away in this case also, and is presumably the only possible source of the agglutinating substance. (2) Eggs deprived of jelly by shaking continue to produce the fertilizin as long as eggs with jelly, though in smaller quantities at first, and they are equally capable of fertilization.

The fertilizin is therefore present in large quantities in the jelly, which is indeed saturated with the substance, but the eggs continue to produce it as long as they remain alive and unfertilized. When the eggs are

fertilized the production of this substance suddenly ceases absolutely.

The total disappearance of fertilizin from fertilized eggs can not be demonstrated unless the fertilizin-saturated jelly with which the eggs are surrounded be first removed. This is very easily done after membrane formation by six vigorous shakes of the eggs in a half-filled test tube. Three or four washings then are sufficient to remove the remains of the jelly, and the naked eggs no longer produce the substance.

Such disappearance may be due either to complete discharge from the egg, or to fixation of all that remains by union with some substance contained in the egg itself. That such a substance—anti-fertilizin—exists in the egg can be shown by a simple test-tube experiment: If eggs deprived of jelly are washed 34 times in sea water during three days, they are so exhausted that they produce but little fertilizin; the supernatant fluid may be charged only to the extent of 2 to 10 units. The eggs are now on the point of breaking up. If they are then vigorously shaken and broken up so that the fluid becomes colored with the red pigment of the eggs, it will be found that agglutinating power has entirely disappeared from the solution. The fertilizin present has been neutralized. The same phenomenon may be demonstrated also by treating eggs, deprived of jelly in order to get rid of excess of fertilizin, with distilled water which lakes the eggs and extracts the anti-fertilizin.

It is probable, therefore, that any excess of fertilizin remaining in the egg not bound to the sperm is neutralized by this combination, and polyspermy is thereby prevented.

We have noted (1) the secretion by unfertilized eggs in sea water of a sperm agglutinating substance, fertilizin; (2) the extreme avidity of the sperm for it as shown by dilution tests; (3) in my previous papers the fixation of this substance in sperm-suspensions of the same species (quantitative measurements will be given in the complete paper); (4) the sudden cessation of fertilizin production by fertilized eggs; (5) the existence of an anti-fertilizin in the egg; (6) in eggs submitted to a series of washings decrease of the fertilization capacity with reduction of the fertilizin. The fact that fertilized eggs can not be refertilized is associated with the absence of free fertilizin in them; (7) I may add that, similarly, eggs in which membrane formation has been induced by butyric acid can not be fertilized by sperm and they contain no free fertilizin.

It is therefore very probable that the substance in question is essential for fertilization.

It may be maintained that these facts do not constitute demonstrative evidence of the necessity of this substance for fertilization, for the presence or absence or diminution of this material associated with presence or absence or decrease of fertilizing power could always be regarded as a secondary phenomenon. However, the second part of this paper dealing with the other, or ovophile side-chain of the fertilizin, strongly reinforces the argument.

Before passing on to this, I may be allowed to note some other properties of the fertilizin: In my previous papers I noted the extreme heat-resistance of the fertilizin, being only slowly destroyed at 95° C. I also noted that strongly agglutinating solutions of *Arbacia* may contain a substance which agglutinates *Nereis* sperm and stated that this was probably different from the iso-agglutinating substance. This turns out to be the case and the two can be readily separated. The substance must possess great molecular size, as it is incapable of passing through a Berkefeld filter. It is also non-dialyzable; it does not give the usual protein reactions, a fact for the determination of which I am indebted to Dr. Otto Glaser.

2. *The Ovophile Side-chain.*—Assuming, then, that the union of this substance with the spermatozoon enters in some significant way into the process of fertilization, the problem was to ascertain in what way. The simplest idea, viz., that the union is in itself the fertilization process, was soon shown to be untenable, for the reason that the perivisceral

fluid (blood) of the sea-urchin, especially of ripe males and females, often contains a substance which absolutely inhibits fertilization in the presence of any quantity of sperm, but that this substance has no inhibiting effect at all upon the sperm-agglutination reaction. It does not enter into combination with the spermophile side-chain. In other words, the binding of the agglutinin by the sperm may be complete, but in the presence of an inhibitor contained in the blood none of the usual effects of insemination, no matter how heavy, follow.

The details of the experiments upon which the above statement depends are too complex for consideration here. But they showed that the effect is neither upon the egg alone nor upon the sperm alone, for both may stand for some time in the presence of this agent and after washing be capable of normal behavior in fertilization, though there may be some decrease in the percentages. No poisonous effect is involved on either sexual element.

The next suggestion was fairly obvious, viz., that the substance which we had been calling agglutinin, on account of its effect upon the spermatozoa, is in reality an amboceptor with spermophile and ovophile side-chains, and that the binding of the sperm activates the ovophile side-chains which then seize upon egg receptors and fertilize the egg. If this were so, it is obvious that the spermatozoon is only secondarily a fertilizing agent, in the sense of initiating development, and that the egg is in reality self-fertilizing, an idea which agrees very well with the facts of parthenogenesis and the amazing multiplicity of means by which parthenogenesis may be effected. For the agents need only remove obstacles to the union of the amboceptor and egg receptor.

The inhibiting action of the blood from this point of view is a deviation effect due to occupancy of the ovophile side-chain of the amboceptor, either because the inhibitor in the blood is an anti-body to the amboceptor or because it possesses the same combining group as the egg receptor. In such a case, the ovophile group of the amboceptor, being already occupied by the inhibitor, fertilization could not take place.

Fortunately, this idea is susceptible of a ready test; for, if the blood acts in this way in inhibiting fertilization, all that is necessary to neutralize the inhibiting action would be to occupy the inhibitor by the amboceptor (fertilizin) for which *ex. hyp.* it has strong affinity. This experiment was repeated many times in different ways with various dilutions, and the result was always to lessen or completely remove the inhibiting action of the blood.

The plan of such an experiment is this: to divide the filtered blood (plasma) in two parts, one of which is used for control while the other is saturated with fertilizin by addition of eggs. In ten minutes the latter are precipitated by the centrifuge and the supernatant fluid filtered. Fertilizations are then made in graded dilutions of this and the control blood. In some cases the inhibiting action of the blood was completely neutralized, and in all largely neutralized.

The results so far are in agreement with the theory. But if it be true that the egg contains its own fertilizing substance, it might also be possible to induce parthenogenesis by increasing the concentration of this substance to a certain point; though it is conceivable that no increase in concentration would break down the resistance that normally exists to union of the amboceptor and egg receptors. As a matter of fact, Dr. Otto Glaser[2] has shown this summer that a certain amount of parthenogenetic action may be induced in *Arbacia* in this way. I have been in consultation with Dr. Glaser during part of his work and can confirm his statements.

In connection with the assumption that the sperm activates an already existing side-chain of a substance contained in the egg itself, I may be allowed to cite the following statement of Ehrlich:

> The significance of the variations in affinity will be discussed connectedly at a subsequent time. We shall content ourselves here by pointing out

2 Science, N. S., Vol. XXXVIII., No. 978, September 26, 1913, p. 446.

that an understanding of the phenomena of immunity is impossible without the assumption that certain haptophore groups become increased or decreased in their chemical energy, owing to changes in the total molecule. Chemically, such an assumption is a matter of course.[8]

This principle might explain the activation of the fertilizing amboceptor by the sperm.

The question will of course be raised whether there is not another and simpler interpretation of the facts. There are three general classes of these facts: (1) the sperm agglutination phenomena, and the apparent necessity of the agglutinating substance for fertilization; (2) the presence of an inhibiting agent in the blood, especially of ripe males and females; (3) the neutralization of this inhibiting agent by the agglutinating agent (amboceptor). It may be questioned whether these facts have the particular causal nexus that I have given them. But I think it would be difficult to construct a theory taking account of all the facts which would differ essentially from that presented here.

The theory is really extremely simple in its character, and the facts on which it rests are readily tested. It has proven a most valuable working hypothesis; indeed, many of the facts referred to were discovered only after the theory was formed. It has the advantage of offering one theory for initiation of development whether by fertilization or by parthenogenesis. It is capable of explaining the whole range of specificities in fertilization by assuming a specific fertilizin for each species. It furnishes the foundation for the chemical conceptions necessary to any theory of fertilization, and it is susceptible of experimental test.

It will be seen that inhibition of fertilization may occur by block in any part of the mechanism.

1. Through loss of fertilizin by the egg.

2. Through occupancy of the sperm receptors.

3. Through occupancy of the egg receptors.

4. Through occupancy of the ovophile side-chain of the amboceptor (fertilizin).

5. Through occupancy of the spermophile side-chain group.

Of these I have shown the occurrence of the first, fourth and fifth in *Arbacia*. The first in the case of long-washed eggs; the fourth in the case of the inhibitor contained in the blood; the fifth is, I believe, the mechanism for prevention of polyspermy.

The mechanism of fertilization appears to be the same in *Nereis*, though I have not a complete set of data. However, the data that I have are in accord with the theory, and will be described in the complete paper.

I should perhaps state specifically that the location of the fertilizin is in the cortex of the egg.

It seems to me probable that the activation of the fertilizin is by no means confined to that bound by the single penetrating sperm, but that activation once set up spreads around the cortex. The supernumerary spermatozoa that fail to enter the egg may also play a part by setting up centers of activation. In this connection Glaser's contention that several spermatozoa at least are necessary for fertilization is of great interest. The nature of the effect of the activated fertilizin on the egg is analogous in some respects to a superficial cytolysis, in this respect agreeing with Loeb's theory. But the "lysin" is contained in the egg, not in the sperm, as Loeb thought; if cytolysis is involved, it is a case of autocytolysis. This may involve increase of permeability, the effects of which R. S. Lillie has especially studied. I mention these possibilities in order to point out that the conception contained in this paper is not in conflict with the well-established work of others.

In conclusion, I may point out that the theory assumes a form of linkage of sperm and egg components by means of an intermediate body that may find a place in the study of heredity. The detailed experiments will be published later.

Frank R. Lillie

Marine Biological Laboratory,
Woods Hole, Mass.,
September 1, 1913

[8] "Collected Studies in Immunity," p. 220.

SCIENCE

FRIDAY, OCTOBER 17, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE RESULT OF THE LAST TWENTY YEARS OF AGRICULTURAL RESEARCH[1]

I PROPOSE to follow the example of my predecessor of last year, in that the remarks I wish to make to-day have to deal with the history of agriculture. Unlike Mr. Middleton, however, whose survey of the subject went back almost to prehistoric times, I propose to confine myself to the last quarter of a century—a period which covers what I may perhaps be permitted to call the revival of agricultural science.

Twenty-five years ago institutions concerned with the teaching of agriculture or the investigation of agricultural problems were few and far between. I do not propose to waste time in giving an exhaustive list, nor would such a list help me in developing the argument I wish to lay before the section. It will serve my purpose to mention that organized instruction in agriculture and the allied sciences was already at that date being given at the University of Edinburgh and at the Royal Agricultural College, whilst, in addition, one or more old endowments at other universities provided courses of lectures from time to time on subjects related to rural economy. Agricultural research had been in progress for fifty years at the Rothamsted Experimental Station, where the work of Lawes and Gilbert had settled for all time the fundamental principles of crop production. Investigations of a more practical nature had also been commenced by

[1] Section M: Birmingham, 1913. Address of the president to the Agricultural Section of the British Association for the Advancement of Science.

the leading agricultural societies and by more than one private land-owner.

In these few sentences I have endeavored to give a rough, but for my purpose sufficient, outline of the facilities for the study of agricultural science twenty-five years ago, at the time when the county councils were created. Their creation was followed almost immediately by what can only be called a stroke of luck for agriculture. The chancellor of the exchequer found himself with a considerable sum of money at his disposal, and this was voted by Parliament to the newly created county councils for the provision of technical instruction in agriculture and other industries.

Farmers were at that time struggling with the bad times following the wet seasons and low prices of the 'seventies and 'eighties, and some of the technical instruction grant was devoted to their assistance by the county councils, who provided technical instruction in agriculture. Thus, for the first time considerable sums provided by the government were available for the furtherance of agricultural science; and, although at first there was no general plan of working and every county was a law unto itself, the result has been a great increase of facilities for agricultural education and research.

Almost every county has taken some part. The larger and richer counties have founded agricultural institutions of their own. In some cases groups of counties have joined together and federated themselves with established teaching institutions. For my purpose it suffices to state, without going into detail, that in practically every county, in one way or other, attempts have been made to carry out investigations of problems related to agriculture.

Twenty years after the voting of the technical instruction grant to the county councils, parliament has again subsidized agriculture, in the shape of the development fund, by means of which large sums of money have been devoted to what may be broadly called agricultural science. It seems to me that the advent of this second subsidy is an occasion when this section may well pause to take stock of the results which have been achieved by the expenditure of the technical education grant. I do not propose to discuss the results achieved in the way of education, although most of the technical instruction grant has been spent in that direction. It will be more to the point in addressing the Agricultural Section to discuss the results obtained by research.

The subject, then, of my address is the result of the last twenty years of agricultural research, and I propose to discuss both successes and failures, in the hope of arriving at conclusions which may be of use in the future.

Agricultural science embraces a variety of subjects. I propose to consider first the results which have been obtained by the numerous practical field experiments which have been carried out in almost every county. I suppose that the most striking result of these during the last twenty years is the demonstration that in certain cases phosphates are capable of making a very great increase in the crop of hay, and a still greater increase in the feeding value of pastures. This increase is not yielded in all cases, but the subject has been widely investigated, and the advisory staffs of the colleges are in a position to give inquirers reliable information as to the probability of success in almost any case which may be submitted to them. This is a satisfactory state of things, and the question naturally arises: How has it come about?

On looking through the figures of the numerous reports which have been pub-

lished on this subject, it appears at once that in many cases the increase in live-weight of sheep fed on plots manured with a suitable dressing of phosphate has been twice as great as the increase in weight of similar animals fed on plots to which phosphate has not been applied. Now about a difference of this magnitude between two plots there can be no mistake. It has been shown by more than one experimenter that two plots treated similarly in every way are as likely as not to differ in production from their mean by five per cent. of their produce, and this may be taken as the probable error of a single plot. Where, as in the case of many of the phosphate experiments, a difference of 100 per cent. is recorded, a difference of twenty times the probable error, the chances amount to a certainty that the difference is not an accidental variation, but a real effect of the different treatment of the two plots. The single-plot method of conducting field trials, which is the one most commonly used, is evidently a satisfactory method of measuring the effects of manures which are capable of producing 100 per cent. increases. It was good enough to demonstrate with certainty the effects of phosphate manuring on many kinds of grass land, and it is to this fact that we owe one of the most notable achievements of agricultural science in recent years.

Another notable achievement is the discovery that in the case of most of the large-cropping varieties of potatoes the use of seed from certain districts in Scotland or the northern counties of Ireland is profitable. This is another instance of an increase large enough to be measured accurately by the single-plot method. Reports on the subject show that seed brought recently from Scotland or Ireland gives increased yields of from thirty to fifty per cent. over the yields produced by seed grown locally for three or more years.

That the single-plot method fails to give definite results in many cases where it has been used for manurial trials is a matter of common knowledge. Half the reports of such trials consist of explanations of the discrepancies between the results obtained and the results which ought to have been obtained. The moral is obvious. The single-plot method, which suffices to demonstrate results as striking as those given by phosphates on some kinds of pasture land, signally fails when the subject of investigation is concerned with differences of ten per cent. or thereabouts.

Before suggesting a remedy for this state of things it will be well to consider the allied subject of variety testing, which has been brought into great prominence recently by the introduction of new varieties of many kinds of farm crops. In testing a new variety it is necessary to measure two properties—its quality and its yielding capacity—for money-return per acre is obviously determined by the product of yielding capacity and quality as expressed by market price. I propose here to deal only with the determination of yielding capacity. The determination of quality is not allied to manurial trials.

In attempting to determine yielding capacity there has always been a strong temptation to rely on the measurement of obvious structural characters. For instance, in the case of cereals many farmers like large ears, no doubt with the idea that they are an indication of high yielding capacity. Many very elaborate series of selections have been carried out, on the assumption that large grains, or large ears, or many ears per plant implied high yield.

We may take it as definitely settled that none of these characters is reliable, and that the determination of yielding capacity re-

solves itself into the measurement of the yield given by a definite area. The actual measurement, therefore, is the same as that made in manurial trials, and is, of course, subject to the same probable error of about five per cent.

It follows, therefore, that it is subject to the same limitations. Variety trials on single plots, and that is the method commonly used, will serve to measure variations in yielding capacity of thirty per cent., or more, but are totally inadequate to distinguish between varieties whose yielding capacities are within ten per cent. of each other.

Numbers of such single-plot trials have been carried out, with the result that many varieties with yielding capacities much below normal have almost disappeared from cultivation, and those commonly grown do not differ greatly from one another—probably not more than ten per cent.

Ten per cent. in yielding capacity, however, in cereals means a return of something like 15 shillings to 20 shillings per acre—a sum which may make the difference between profit and loss; and if progress is to be made in manuring and variety testing some method must be adopted which is capable of measuring accurately differences in yield per unit area of the order of ten per cent.

The only way of decreasing the probable error is to increase the number of plots; and to arrange them so that plots between which direct comparison is necessary are placed side by side, so as to reduce as much as possible variations due to differences in soil. Thus it has been shown that with ten plots in five pairs the probable error on the average can be reduced to about one per cent., in which case a difference of from five to ten per cent. can be measured with considerable certainty.

Such a method involves, of course, a great deal of trouble; but agricultural science has now reached that stage of development at which the obvious facts which can be demonstrated without considerable effort have been demonstrated, and further knowledge can only be acquired by the expenditure of continually increasing effort. In fact, the law of diminishing return holds here, as elsewhere.

It appears, then, that for questions involving measurements of yield per unit area, such, for instance, as manurial or variety trials, further advance is not likely to be made without the expenditure of much more care than has been given to such work in the past. The question naturally arises: Is it worth while? I think the following instance shows that it is:

Some years ago an extensive series of variety trials was carried out in Norfolk, in which several of the more popular varieties of barley were grown side by side at several stations for several seasons. In all, the trial was repeated eleven times. As a final result it was found that Archer's stiff-straw barley gave ten per cent. greater yield than any other variety included in the trials, and by repetition of the experiment the probable error was reduced to one and a half per cent. The greater yield of ten per cent., being over six times the probable error of the experiment, indicates practical certainty that Archer barley may be relied on to give a larger crop than any of the other varieties with which it was compared. One difficulty still remained. It was almost impossible to obtain anything like a pure strain of Archer barley. Samples of Archer sold for seed commonly contained twenty-five per cent. of other varieties. This difficulty was removed by Mr. Beaven, who selected, again with enormous trouble, a pure high-yielding strain of Archer barley. Since this strain was introduced into the eastern counties the demand for it has always exceeded the

supply which could be grown at Cambridge and at the Norfolk Agricultural Station, and it is regarded by farmers generally as a very great success.

The conclusion, therefore, is that a ten-per-cent. difference is well worth measuring, that it can not be measured with certainty by the single-plot method, and that it behooves those of us who are concerned with field trials to look to our methods, and to avoid printing figures for single-plot experiments which may very well be misleading. Almost every one thinks himself competent to criticize the farmer, who is commonly described as too self-satisfied to acquaint himself with new discoveries, and too conservative to try them when they are brought to his notice. Let us examine the real facts of the case. Does the farmer ignore new discoveries? The largely increasing practise of consulting the staffs of the agricultural colleges, which has arisen among farmers during the last few years, conclusively shows that he does not; that he is, in fact, perfectly ready to avail himself of sound advice whenever he can. Is he too conservative to try new discoveries when brought to his notice? The extraordinary demand for seed of the new Archer barley quoted above, and for seed of new varieties generally, the continuous advance in the prices of phosphatic manures, as the result of increased demand by farmers, the trade in Scotch and Irish seed potatoes, all show how ready the farmer is to try new things. The chief danger seems to be that he tries new things simply because they are new, and he may be disappointed if those who are responsible for the new things in question have not taken pains to ascertain with certainty that they are not only new, but good. Farmers are nowadays in what may be called a very receptive condition. Witness the avidity with which they paid extravagant prices for single tubers of so-called new, but inadequately tested, varieties of potatoes some years ago, and in a less degree the extraordinary demand for seed of the much-boomed French wheats, and the excitement about nitragin for soil or seed inoculation. Witness, too, the almost universal failure of the new potatoes and French wheats introduced during the boom, and the few cases in which nitragin gave any appreciable result. The farmer who was disappointed with his ten-guinea tuber, his expensive French wheat, or his culture of nitragin can not but be disillusioned. Once bitten, twice shy. He does not readily take advice again.

Let us, therefore, recognize that the farmers of the country are ready to listen to us, and to try our recommendations, and let that very fact bring home to us a sense of our responsibility. All that is new is not, therefore, necessarily good. Before we recommend a new thing let us take pains to assure ourselves of its goodness. To do so we must find not only that the new thing produces a greater return per acre, but that the increased return is worth more than it costs to produce, and we must also define the area or the type of soil to which this result is applicable. This implies in practise that each field trial should confine itself to the investigation of only one, or, at most, two, definite points, since five pairs of plots will be required to settle each point; that the experimental results should be reviewed in the light of a thorough knowledge of farm book-keeping, and that accurate notes should be taken of the type of the soil, and the area to which it extends, and of the various meteorological factors which make up the local climate. At present we are not in possession of a sufficient knowledge of farm accountancy, but there is hope that this deficiency will be removed by the work of the Institute for Research in Agriculture Economics, which has recently been founded

at Oxford by the board of agriculture and the development commission. The excellent example set by Hall and Russell in their "Survey of the Soils and Agriculture of the Southeastern Counties," an example which is being followed in Cambridge and elsewhere, seems likely to result in the near future in a complete survey of the soils of England which will make a sound scientific basis for delimiting the areas over which the results of manurial or variety trials are applicable.

Reviewing this branch of agricultural science, the outlook is distinctly hopeful. New fertilizers are coming into the market, as, for instance, the various products made from atmospheric nitrogen. New varieties of farm crops are being produced by the Plant-breeding Institute at Cambridge, and elsewhere. It is to be hoped that the work of the Agricultural Economics Institute at Oxford will throw new light on the interpretation of experimental results from the accountancy standpoint. Finally, the soil surveys on which the colleges have seriously embarked will assist in defining the areas over which such results are applicable. It only remains for those of us who are responsible for the conduct of field trials to increase the accuracy of our results, and the steady accumulation of a mass of systematic and scientific knowledge is assured. It will be the business of the advisory staffs with which the colleges have recently been equipped by the board of agriculture and the development commission to disseminate this knowledge in practicable form to the farmers of this country.

One more point, and I have finished this section of my address. I have perhaps inveighed rather strongly against the publication of the results of single-plot trials. I quite recognize that the publication of such results was to a great extent forced upon those experimenters who were financed by annually renewed grants of public money. Nowadays, however, agricultural science is in a stronger position, and I venture to hope that most public authorities which subsidize such work are sufficiently alive to the evils attendant on the publication of inconclusive results to agree to continue their grants for such periods as may suffice for the complete working out of the problem under investigation, and to allow the final conclusions to be published in some properly accredited agricultural journal, where they would be readily and permanently available to all concerned. This would in no wise prevent their subsequent incorporation in bulletins specially written for the use of the practical farmer.

So far I have confined my remarks to subjects of which I presume that every member of the section has practical experience, subjects which depend on the measurement of the yield per unit area. These subjects, however, although they have received far more general attention than anything else, by no means comprise the whole of agricultural science. Certain scientific workers have confined their efforts to the thorough solution of specific and circumscribed problems. I propose now to ask the section to direct its attention to some typical results which have been thus achieved during the last twenty years.

The first of these is the development of what I may call soil science. Twenty years ago the bacteriology of nitrification had just been worked out by Warington and by Winogradski. The phenomena of ammoniacal fermentation of organic matter in the soil were also fairly well established. The fixation of atmospheric nitrogen by organisms symbiotic on the leguminosæ had been definitely demonstrated. Fixation of nitrogen by free-living organisms had been suggested, but was still strenuously denied by most soil investigators. No suggestion had

yet been made of the presence in normal soils of any factor which inhibited crop-production. The last twenty years have seen a wonderful advance in soil science. Our knowledge of nitrification and ammoniacal fermentation has been much extended. The part played by the nodule organisms of the leguminosæ has been well worked out, has seen a newspaper boom, and a subsequent collapse, from which it has not yet recovered. But the greatest advance has been the discovery of the part played by protozoa in the inhibition of fertility.

The suggestion that ordinary soils contained a factor which limited their fertility emanated in the first instance from the American Bureau of Soils. The factor was at first thought to be chemical, and its presence was tentatively attributed to root excretion. Certain organic substances, presumably having this origin, have been isolated from sterile soils, and found to retard plant growth in water culture. It is claimed, too, that the retardation they cause is prevented by the presence of many ordinary manurial salts with which they are supposed to form some kind of combination.

Contributions to the subject have come from several quarters, but whilst the suggested presence of an inhibitory factor has been generally confirmed, its origin as a root-excretion and its prevention by manurial salts has not received general confirmation outside American official circles. The matter has been strikingly cleared up by the work of Russell and Hutchinson at Rothamsted, who observed that the fertility of certain soils which had become sterile was at once restored by partial sterilization, either by heating to a temperature below 100° C., or by the use of volatile antiseptics such as toluene. This observation suggested that the factor causing sterility in these cases was biological in nature, that it consisted, in fact, of some kind of organism inimical to the useful fermentation bacteria, and more easily killed than they by heat or antiseptics. After a long series of admirable scientific investigations these workers and their colleagues have shown that soils contain many species of protozoa, which prey upon the soil bacteria, whose numbers they keep within definite limits. Under certain circumstances, such, for instance, as those existing in the soil of sewage farms, and in the artificial soils used for the cultivation of cucumbers, tomatoes, etc., under glass, the protozoa increase so that the bacteria are reduced below the numbers requisite to decompose the organic matter in the soil into substances suitable for absorption by the roots of the crop. Practical trials of heating such soils, or subjecting them to the action of toluene, or other volatile antiseptics, have shown that their lost efficiency can thus be easily restored, and the method is now rapidly spreading among the market gardeners of the Lea Valley.

I have attempted to sketch the chief points of this subject with some detail in order to show that strictly scientific work, quite outside the scope of what some people still regard as "practical," may result in discoveries which, apart from their great academic interest, may at once be turned to account by the cultivator. The constant renewal of expensively prepared soil which becomes "sick" in the course of a year or so is a serious item in the cost of growing cucumbers and tomatoes. It can now be restored to fertility by partial sterilization at a fraction of the cost of renewal, and considerable sums are thus saved by the Lea Valley growers.

For my second instance of scientific work which has given results of direct value to farmers, I must ask to be allowed to give a short outline of the wheat-breeding investigations of my colleague Professor Biffen,

Even as late as fifteen years ago plant-breeding was in the purely empirical haphazard stage. Then came the rediscovery of Mendel's laws of heredity, which put in the hands of breeders an entirely new weapon. About the same time the Millers' Association created the Home-grown Wheat Committee, of which Biffen was a member. Through this committee he was able to define his problem as far as the improvement of English wheat was concerned. There appeared to be two desiderata: (1) The production of a wheat which would crop as well as the best standard home-grown varieties, at the same time yielding strong grain, *i. e.*, grain of good milling and baking quality; and (2) the production of varieties of wheat resistant to yellow rust, a disease which has been computed to decrease the wheat crop of the world by about one third.

The problem having been defined, samples of wheat were collected from every part of the world and sown on small plots. From the first year's crop single ears were picked out and grown on again. Thus several hundred pure strains were obtained. Many were obviously worthless. A few possessed one or more valuable characteristics: strong grain, freedom from rust, sturdy straw, and so on. These were used as parents for crossing, and from the progeny two new varieties have been grown on, thoroughly tested, and finally put on the market. Both have succeeded, but both have their limitations. Burgoyne's Fife, which came from a cross between strains isolated respectively from Canadian Red Fife and Rough Chaff, was distributed by the Millers' Association after a series of about forty tests, in which it gave an average crop of forty bushels per acre of grain, which milled and baked practically as well as the best imported Canadian wheat. It is an early-ripening variety which may even be sown as a spring wheat. It has repeatedly been awarded prizes for the best sample of wheat at shows, but it only succeeds in certain districts. It is widely and successfully grown in Bedfordshire and Dorset, but has not done well in Norfolk. The other variety, Little Joss, succeeds much more generally. In a series of twenty-nine trials scattered between Norfolk and Shropshire, Kent and Scotland, it gave an average of forty-four bushels per acre, as compared with forty bushels given by adjoining plots of Square Head's Master. It originated from a cross between Square Head's Master and a strain isolated from a Russian graded wheat known as Glinka. Its grain is the quality of ordinary English wheat It tillers exceptionally well in the spring, and is practically rust-proof. Its one drawback is its slow growth during the winter if sown at all late. It has met with its greatest success in the Fen districts, where rust is more than usually virulent.

The importance of this work is not to be measured only by the readiness with which the seed of the new varieties has been tried by farmers and the extent to which it has succeeded. The demonstration of the inheritance of immunity to the disease known as yellow rust, the first really accurate contribution to the inheritance of resistance to any kind of disease, inspires hope that a new method has appeared for the prevention of diseases in general.

Biffen's work too shows the enormous value of cooperation between the investigator and the buyer in defining problems connected with the improvement of agricultural produce. It is open to doubt if a committee of farmers would have been able to define the problems of English wheat production as was done by the Millers' Committee, and in the solution of any problem its exact definition is half the battle. Mackenzie and Marshall in their work on

the "Pigmentation of Bacon Fat" and on the spaying of sows for fattening, have found the great value of consultation with the staffs of several large bacon factories. There seems to be in this a general lesson that before taking up any problem one should get into touch not only with the producers, but with the buyers, from whom much useful information can be obtained.

I feel that Biffen's work has borne fruit in still another direction, for which perhaps he is not alone responsible. Twenty years ago agricultural botany took a very subsidiary position in such agricultural examinations as then existed. In some of the agricultural teaching institutions there was no botanist, in others the botanist was only a junior assistant. It is largely due to the work of Biffen and the botanists at other agricultural centers that botany is now regarded as perhaps the most important science allied to agriculture.

I must here repeat that I am not attempting to make a complete survey of all the results obtained in the last twenty years. My object is only to pick out some of the typical successes and failures and to endeavor to draw from their consideration useful lessons for the future. So far I have not referred to the work which has been done in the nutrition of animals, and I now propose to conclude with a short discussion of that subject. The work on that subject which has been carried out in Great Britain during the last twenty years has been almost entirely confined to practical feeding trials of various foods or mixtures of foods, trials which have been for the most part inconclusive.

It has been shown recently that if a number of animals in store condition are put on a fattening diet, at the end of a feeding period of twelve to twenty weeks about half of them will show live-weight increases differing by about fourteen per cent. from the average live-weight increase of the whole lot. In other words, the probable error of the live-weight increase of a single fattening ox or sheep is fourteen per cent. of the live-weight increase. This being so, it is obvious that very large numbers of animals must be employed in any feeding experiment which is designed to compare the feeding value of two rations with reasonable accuracy. For instance, to measure a difference of ten per cent. it is necessary to reduce the probable error to three per cent. in order that the ten per cent. difference may have a certainty of thirty to one. To achieve this, twenty-five animals must be fed on each ration. Those conversant with the numerous reports of feeding trials which have been published in the last twenty years will agree that in very few cases have such numbers been used. We must admit then that many of the feeding trials which have been carried out can lay no claim to accuracy. Nevertheless, they have served a very useful purpose. From time to time new articles of food come on the market, and are viewed with suspicion by the farmers. These have been included in feeding trials and found to be safe or otherwise, a piece of most useful information. Thus, for instance, Bombay cotton cake, when first put on the market, was thought to be dangerous on account of its woolly appearance. It was tried, however, by several of the agricultural colleges and found to be quite harmless to cattle. Its composition is practically the same as that of Egyptian cotton cake, and it now makes on the market practically the same price.

Soya-bean cake is another instance of a new food which has been similarly tested, and found to be safe for cattle if used in rather small quantities and mixed with cotton cake. The price is now rapidly rising to that indicated by its analysis. Work of this kind is, and always will be, most

useful. Trials with few animals, whilst they can not measure accurately the feeding value of a new food, are quite good enough to demonstrate its general properties, and its price will then gradually settle itself as the food gets known.

Turning to the more strictly scientific aspects of animal nutrition, entirely new ideas have arisen during the last twenty years. I propose to discuss these shortly, beginning with the proteins. Twenty years ago the generally accepted view of the rôle of proteins in nutrition was that the proteins ingested were transformed in the stomach and gut into peptones, and absorbed as such without further change. Splitting into crystalline products, such as leucin and tyrosin, was thought only to take place when the supply of ingested protein exceeded the demand, and peptones remained in the gut for some time unabsorbed. It is now generally agreed that ingested protein is normally split into crystalline products which are separately absorbed from the gut, and built up again into the various proteins required by the animal. If the ingested protein does not yield a mixture of crystalline products in the right proportions to build up the proteins required, those crystalline products which are in excess are further changed and excreted. If the mixture contains none of one of the products required by the animal, then life can not be maintained. This has been actually demonstrated in the case of zein, one of the proteins of maize, which contains no tryptophane. The addition of a trace of tryptophane to a diet, in which zein was the only protein, markedly increased the survival period of mice.

The adoption of this view emphasizes the importance of a knowledge of the composition of the proteins, and especially of a quantitative knowledge of their splitting products, and much work is being directed to this subject in Germany, in America, and more recently in Cambridge as a result of the creation there of an Institute for Research in Animal Nutrition by the Board of Agriculture and the Development Commission. This work is expected ultimately to provide a scientific basis for the compounding of rations, the idea being to combine foods whose proteins are, so to speak, complementary to each other, one giving on digestion much of the products of which the other gives little. Meantime, it is desirable that information should be collected as to mixtures of foods which are particularly successful or the reverse.

Here the question arises, for what purpose does the animal require a peculiarly complicated substance like tryptophane? The natural suggestion seems to be that the tryptophane grouping is required for the building up of animal proteins. It has also been suggested that such substances are required for the formation of hormones, the active principles of the internal secretions whose importance in the animal economy has received such ample demonstration in recent years. The importance of even mere traces of various substances in the animal economy is another quite recent conception. Thus it has been shown, both in Cambridge and in America, that young animals fail to grow on a diet of carefully purified casein, starch, fat and ash, although they will remain alive for long periods. In animals on such a diet, however, normal growth is at once started by the addition of a few drops of milk or meat juice, or a trace of yeast, or other fresh animal or vegetable matter. The amount added is far too small to affect the actual nutritive value of the diet. Its effect can only be due to the presence of a trace of some substance which acts, so to speak, as the hormone of growth. The search for such a substance is now being actively prosecuted. Its discovery will be

of the greatest scientific and practical interest.

Evidently new ideas are not lacking amongst those who are engaged in investigating the rôle of the proteins and their splitting products in the animal economy. But of more immediate practical interest is the question of the amount of protein required by animals under various conditions. It is obviously impossible to fix this amount with any great accuracy, since proteins differ so widely in composition, but from many experiments, in which a nitrogen balance between the ingesta and the excreta was made, it appears that oxen remain in nitrogenous equilibrium on a ration containing about one pound of protein per 1,000 lbs. live-weight per day. All the British experiments of a more practical nature have been recalculated on a systematic basis by Ingle, and tabulated in the *Journal of the Highland and Agricultural Society*. From them it appears that increase of protein in the ration, beyond somewhere between one and a half and two pounds per 1,000 pounds live-weight per day of digestible protein, ceases to have any direct influence on increase in live-weight.

We may fairly conclude, then, that about two pounds of protein per 1,000 pounds live-weight per day is sufficient for a fattening ox. This amount is repeatedly exceeded in most of the districts where beef production is a staple industry, the idea being to produce farmyard manure rich in nitrogen. The economy of this method of augmenting the fertility of the land is very doubtful. The question is one of those for the solution of which a combination of accurate experiment and modern accountancy is required. Protein is the most expensive constituent of an animal's dietary. If the scientific investigator, from a study of the quantitative composition of the proteins of the common farm foods, and the economist, from careful dissection of farm accounts, can fix an authoritative standard for the amounts of protein required per 1,000 lb. live-weight per day for various types of animals, a great step will have been made towards making mutton and beef production profitable apart from corn-growing.

For many years it has been recognized that an animal requires not only so much protein per day, but a certain quota of energy, and many attempts have been made to express this fact in intelligible terms. Most of them have taken as basis the expression of the value of all the constituents of the diet in terms of starch, the sum of all the values being called the starch equivalent. This term is used by various writers in so many different senses that confusion has often arisen, and this has militated against its general acceptance. Perhaps the most usual sense in which the term is used is that in which it means the sum of the digestible protein multiplied by a factor (usually 1.94) plus the digestible fat multiplied by a factor (usually 2.3), plus the digestible carbohydrates. This, however, gives misleading values which are too high in concentrated foods and too low in bulky foods, the discrepancy being due to the larger proportion of the energy of the bulky foods which is used up in the much greater work of digestion which they require. Kellner and his school have devised a method which measures the starch equivalent by experiment, a much more satisfactory and practical method than any system which depends purely on calculation.

An animal or a number of animals are kept on a maintenance diet so that their weight remains constant. To this diet is added a known weight of starch, and the increase in weight observed. The animal or animals are then placed again on the same maintenance diet for some time, and

then a known weight of the food to be tested is added, and the increase in weight again observed. The data thus obtained indicate that so many pounds of starch produce as much increase in live-weight as so many pounds of the food under experiment, from which it is easy to calculate how many pounds of starch are actually required to produce as much increase in live-weight as 100 lb. of the food under experiment. The starch equivalent thus found expresses an experimentally determined fact which is of immediate practical value in arranging a dietary, its value, however, depending on the accuracy with which it has been determined. Kellner and his colleagues have thus determined the starch equivalents of all the commonly used foods. Their values for concentrated foods, and other foods commonly used in Germany, have been determined with considerable accuracy, and with the method which has also been devised for defining the relation between the experimentally determined equivalent and the equivalent calculated from the analysis by means of a formula, they form by far the most reliable basis for arranging a feeding ration including such kinds of foods.

But roots, which form the staple of the diet of fattening animals in Great Britain, are not used on the same scale in Germany, and Kellner's starch equivalents for roots have not been determined with sufficient accuracy or under suitable conditions to warrant their use for arranging diets under our conditions.

This, and the fact that the term starch equivalent is so widely misunderstood, is no doubt the reason why the Kellner equivalent has not been more generally accepted in Great Britain. An advance will be made in the practise of feeding as soon as the starch equivalent of roots has been accurately determined under our conditions, when the Kellner equivalents will no doubt come into general use.

I have now reached the end of my survey. I recognize that it is very incomplete, and that I have been compelled to neglect whole subjects in which important work has been done. I venture to hope, however, that my words have not been altogether unprofitable. It is somewhat difficult to summarize what is in itself really nothing but a summary. Perhaps, however, I may be allowed to point out once more what appears to me to be the moral of the last twenty years of work in agricultural science.

The many practical field and feeding tests carried out all over the country have demonstrated several very striking results; but, if they are to be continued with profit, more trouble must be taken to insure accuracy. Farmers are ready to listen. It behooves us more than ever to found what we tell them on accurate results.

Besides such practical trials, however, much has been done in the way of individual scientific work. The results thus obtained, as, for instance, Russell and Hutchinson's partial sterilization of soils, Biffen's new wheats, and Beaven's pure Archer barley, are of practical value to the farmer as immediate as the most practical field trial, and of far wider application.

T. B. Wood

THE ROYAL GEOGRAPHICAL SOCIETY

Announcement has been made of the plans for the new session of the Royal Geographical Society. The first of the ordinary meetings will be held, as usual, in the Theater, Burlington-gardens, on November 10, when Mr. Raymond E. Priestley will give an account of the work and adventures of the northern party of Captain Scott's Antarctic expedition, for the conduct of which, under the most trying circumstances, it will be remembered Lieutenant Victor Campbell was awarded a gold watch by the society. At the next meeting, on Novem-

ber 24, Mrs. Bullock Workman and Dr. Hunter Workman will give an account of their most recent explorations in the eastern Karakoram. An interesting and perplexing subject will be dealt with at the meeting of December 8 by Professor J. W. Gregory, who will endeavor to answer the question, "Is the Earth Drying Up?" At the first meeting in January, 1914, on the 12th, it is probable that Mr. Griffith Taylor will give a paper on the Federal district and capital, Canberra, of the Commonwealth of Australia. Mr. Griffith Taylor was one of the geologists on Captain Scott's expedition, and made a special survey of the Federal district on behalf of the Australian government. It is also expected that either at one of the evening meetings or at an afternoon meeting Mr. Taylor will deal with the geographical aspects of two sub-expeditions in the Antarctic. At an early meeting in the New Year it is hoped that Dr. Hamilton Rice will give an account of his interesting journeys in the Upper Amazon basin, about which some information was published in a recent number of *The Times*. Other subjects which may be dealt with at subsequent meetings will be "An Expedition to Dutch New Guinea," by A. F. R. Wollaston; "Famous Maps in the British Museum," by J. A. J. de Villiers; "The Anglo-German Boundary Survey in West Africa," by Captain W. P. Nugent, R.A.; "The Gulf Stream," by Commander Campbell Hepworth, C.B.; "Journey through Arabia," by Captain G. E. Leachman; "The Red Sea and the Jordan," by Sir William Willcocks; "Fresh Discoveries in the Eket District of Southern Nigeria," by Mr. P. A. Talbot; "The Atlantic Ocean," by Professor Edward Hull, F.R.S., and "The Panama Canal," by Dr. Vaughan Cornish. The afternoon meetings are held in the map room of the society at 5 P.M., and are devoted mainly to the discussion of questions of a more scientific character than the subjects which occupy the evening meetings. The first of these will take place on November 20, when it is expected that Captain H. G. Lyons, F.R.S., will deal with the subject of "Relief in Cartography." At subsequent meetings Dr. A. Strahan, F.R.S., will give his final report on the river investigation, which has been carried on under the society for some years past. Other subjects will be "Recent Geodetic Work," by Captain E. O. Henrici, R.E.; "The Rainfall of the World," by Professor A. J. Herbertson; "Some Central Asian Problems," by Mr. Douglas Carruthers; "Results of a Recent Journey in Turkestan and Siberia," by Dr. Mackintosh Bell; "Researches in the Natron Lake Region, East Africa," by Mr. John Parkinson, and "The Agricultural Geography of New Zealand," by Mr. F. N. Roxby. There will be two Christmas lectures to young people early in January, one on "Glaciers," by Mr. Alan G. Ogilvie, and the other on "Earthquakes and Upheavals," by Mr. Carus-Wilson. The anniversary meeting and dinner will take place on May 25.

SCIENTIFIC NOTES AND NEWS

THE autumn meeting of the National Academy of Sciences will be held at the Johns Hopkins University, Baltimore, on November 18 and 19.

PROFESSOR FELIX KLEIN, of Göttingen, has been presented by his former pupils with a portrait of himself, painted by Max Liebermann. It will be placed in the mathematical institute of the university as soon as the building is completed.

MR. ROOSEVELT is on his way to South America in response to invitations from Argentina, Brazil and Chile, to deliver addresses on subjects of international social interest. After the delivery of the addresses, Mr. Roosevelt will head a scientific expedition into the tropical interior of South America. This expedition is organized by the American Museum of Natural History, and two naturalists of that museum, Mr. George K. Cherry and Mr. Leo Miller, will accompany Mr. Roosevelt, while the Arctic explorer Mr. Anthony Fiala will have charge of the equipment and route.

SIR DAVID BRUCE will leave England on November 1 for the purpose of concluding his sleeping sickness investigations in Central Africa. He will be accompanied by Lady

Bruce, who is herself a member of the commission.

Professor Paul S. Reinsch, who resigned the chair of political science in the University of Wisconsin to become ambassador to China, has sailed from San Francisco for Yokohama.

Professor P. E. Pope, who held the chair of general chemistry in the Massachusetts Institute of Technology, has retired under the Carnegie Foundation.

Cyril G. Hopkins, professor of agronomy, University of Illinois, has been granted a leave of absence for one year, beginning November 1, in order to accept the position of director of agriculture for the Southern Settlement and Development Organization. This is an organization affected chiefly by the governors of the Southern States and the presidents of railroads in those states, and supported principally by state and railway appropriations. Its primary purpose is "to make a thorough and scientific study of the resources and possibilities [of the South] and the best practical methods of developing the same."

M. Lucien Bull, sub-director of the Marey Institute, Boulogne Sur Seine, has been commissioned by the Société d'Hygiène Alimentaire et d'Alimentation Rationnelle de l'Homme to spend several months in Boston at the nutrition laboratory of the Carnegie Institution of Washington, studying the construction and methods of testing and use of the various respiration calorimeters there installed.

We learn from *Nature* that in connection with the work on animal nutrition which is being conducted at the University of Leeds under a grant from the development commissioners, Dr. H. W. Dudley, of the Herter Research Laboratory, New York, has been appointed lecturer in biochemistry. The experimental station in flax growing, which is also supported by the development commissioners, has been placed under the direction of Mr. F. K. Jackson, formerly of the agricultural departments of the Universities of Leeds and Cambridge.

Dr. E. B. Phelps, of the Massachusetts Institute of Technology, known for his work in sanitary engineering, has accepted a position in the U. S. Public Health Service, Washington.

Dr. Joseph A. Blake has resigned from the chair of surgery at the College of Physicians and Surgeons of Columbia University.

Professor Archibald Barr has resigned from the chair of civil engineering and mechanics at the University of Glasgow.

The officers of the British Mycological Society elected for 1914 are: President, Professor A. H. R. Buller; vice-president, Miss G. Lister; honorary secretary and treasurer, Mr. Carleton Rea. The localities for the spring and autumn meetings are the Forest of Dean and Doncaster.

Dr. Lewis M. Terman, associate professor of education, Stanford University, has been elected a member of the permanent International Committee on School Hygiene and has also been made the vice-president of the Council of Thirty of the American School Hygiene Association.

Mr. James Birch Rorer, mycologist and pathologist to the board of agriculture of Trinidad, British West Indies, is on a visit to the United States. His address while in this country is care of Dr. Erwin F. Smith, Bureau of Plant Industry, Washington, D. C.

Before the Geographic Society of Chicago on October 10 a lecture was given by Professor Walter S. Tower, of the University of Chicago, the title being "A Journey through Northern and Central Chile."

The twenty-first James Forrest lecture of the Institution of Civil Engineers, London, will be delivered in the lecture theater of the new building of the institution, on October 23, by Mr. Alexander Gracie, on "Progress of Marine Construction."

We learn from the *Bulletin* of the American Mathematical Society that owing to the mass of new material which has been found at St. Petersburg and at other places, the Euler commission realizes that it must face a deficit in the publication of Euler's works, unless further funds are provided. The publication of this new matter will necessitate several addi-

tional volumes and involve an unforeseen expense of at least $40,000. To defray this expense it is proposed to form a Euler society, with dues of ten francs per year, the receipts of which are to be devoted entirely to this purpose.

Plans have been completed for publishing the complete works of the late Henri Poincaré. The publication will be undertaken at once by Gauthier-Villars under the direction of the French minister of public instruction and the academy of sciences of Paris.

Professor Louis Kuttner, of Berlin, known for his work on intestinal diseases, died on October 5, aged forty-seven years.

The French toxicologist, Dr. Jules Ogier, has died at sixty years of age.

There are several important places in metallurgy under the Bureau of Mines, to be filled by civil service examination on November 10. The salaries of these positions range from $2,000 to $4,800. Several of the vacancies are in Denver, San Francisco and Pittsburgh.

It is reported that steps are being taken, under the auspices of the Resident-General of France and of his Highness the Bey of Tunis, to establish in Tunisia a reserve in which the disappearing fauna of the country may find immunity from persecution. For this purpose some 4,000 acres of wild mountainous country, with an adjoining marsh of 5,000 acres, have been secured.

The Russian government will establish a physical observatory at Vladivostok and experimental stations on the Pacific coast with the view of cooperating with the authorities of meteorological stations in China and Japan. Mr. S. D. Griboyedov has been commissioned to investigate suitable sites for the proposed stations.

The general reorganization and rearrangement of the Rocky Mountains Park Museum maintained by the park department of the Canadian government at Banff, Alberta, has been carried out by Harlan I. Smith, of the Geological Survey, Canada. The museum has been limited in scope to the Rocky Mountain region of Alberta and British Columbia. Only the collections on hand, local park employees and local supplies were used with the exception of a few labels, maps and books given for the purpose by the Geological Survey, the Milwaukee Public Museum, the American Museum of Natural History of New York, the Conservation Commission of Canada and the Central Experimental Farm at Ottawa. The museum has been divided into the following sections: Mammals, birds, fish, reptiles, insects, plants, minerals, rocks, fossils, weather and Indians, of the Rocky Mountains Park, respectively. Professor Allen, of the University of Alberta and the Geological Survey, assisted in the work of the geological sections. The chief features of the museum are the initiation of large sectional labels, case labels and a few general labels to species, in addition to the individual labels—all interpreting the truths of science in simple words for the tourists who visit the park. The cases and labels have been painted to harmonize with the natural finish of the building and the letters on the labels have been made in the color of the knots and grain of the wood.

Secretary Houston, of the Department of Agriculture, says that the state and federal governments should work together for highway improvement in order that a large proportion of the money annually spent for road construction may not be wasted. In his own department the office of public roads has been demonstrating the value of proper road-building by the construction of certain object-lesson roads, and the forest service is carrying out his idea of national and state cooperation in road building. The law requires that ten per cent. of the gross receipts from the national forests shall be spent in the states in which the forests are situated. This money is expended for road improvement under direct control of the secretary of agriculture. The amount appropriated under this act, based on the receipts of the national forests for the fiscal year ending June 30, 1913, is $234,638.68. From the 1912 receipts for this ten-per-cent. road item, there is an additional $134,831.10, which is still available. In ad-

ministering the ten-per-cent. road fund, forest officers charged with the actual plans and expenditures in the neighborhood of their forests have, in almost all cases, secured an equal or a larger cooperative fund from state authorities for the building of certain pieces of road. With the money thus expended many important roads are being built or put in repair. One on the Wyoming National Forest, six miles long, makes accessible to farmers a large body of timber and opens up a region of great scenic beauty. In northwestern Arizona, part of the fund will be used in connection with the LeFevre-Bright Angel road, important because it makes accessible to tourists the Grand Canyon of the Colorado. In one place, the ocean-to-ocean highway crosses the Apache National Forest, Arizona, and on this project the forest service and the local authorities cooperated enthusiastically. On the Florida national forest in western Florida steel bridges and graded roads have, under the stimulus of this fund, taken the place of corduroy, bog and sand. This federal road fund is now available in all national forest states of the west. Just as fast as returns come in, the forestry officials say, a similar fund will become available in states in which eastern national forests are being secured.

The American Petroleum Society was organized on September 10 at the Experiment Station of the U. S. Bureau of Mines, Pittsburgh, Pa. This organization is the result of an effort of the bureau for the past seven years to bring together the men interested in the petroleum industry. Invitations were sent out in July to the secretaries of twenty-four of the national societies of the United States, inviting them to be present and cooperate in this organization. Eighteen of these societies responded at a meeting on August 1 at the Bureau of Mines. A similar invitation was sent out in August to eight additional societies, making a total of thirty-two societies that were invited to attend the September conference. A large number of these were represented at the meeting on September 10, when the final organization was completed. This society will concern itself with the study of all phases of natural gases and petroleum, including the origin, statistics, conservation, drilling methods, production, transportation, storage, refining and specifications for refined products. At the meeting the constitution and by-laws were adopted, and officers were elected as follows: *president*, C. D. Chamberlin, of the National Petroleum Association, Cleveland, Ohio; *vice-president*, R. Galbreath, of the Independent Oil and Gas Producers' Association of Oklahoma, Tulsa, Okla.; *secretary*, Dr. Irving C. Allen, U. S. Bureau of Mines, Pittsburgh, Pa. It is anticipated that the first annual meeting will be held at some convenient place in the United States in the spring of 1914, and the second annual meeting will be held at the Panama Pacific Universal Exposition in San Francisco in 1915. At the 1915 meeting it is anticipated that all of the petroleum societies in the country will meet in one great congress. An invitation has been sent to the president of the International Petroleum Commission, which meets in January, 1914, in Bucharest, Roumania, to hold its annual meeting for 1915 in San Francisco.

UNIVERSITY AND EDUCATIONAL NEWS

Mrs. W. Bayard Cutting and her children have given $200,000 to Columbia University for a fund in memory of the late W. Bayard Cutting, of the class of '69, who served as trustee of the university from 1880 until his death, in 1912. The income of this fund is to be applied to the maintenance of traveling fellowships, open to graduate students of distinction in letters, science, law and medicine or engineering.

Dr. Gavin Paterson Tennent, of Glasgow, has bequeathed £25,000 to the University of Glasgow, to be applied for such objects or object in connection with the faculty of medicine as the trustees may determine. The university has also received a legacy of £4,000 from the late Mrs. Caird, widow of Principal Caird, to establish two scholarships in classics or mental philosophy, and a legacy of £5,000 by the late Mr. William Weir, ironmaster, the income of which is to pay for an additional assistant to the professor of materia medica.

The construction of two new buildings on the campus of the Ohio State University is progressing rapidly. One will house the departments of botany and zoology and entomology; the other, the departments of forestry and horticulture. They will be of brick construction and will cost $125,000 each, exclusive of equipment.

A new course in applied entomology is offered this year at the Ohio State University. The course covers four years and leads to the degree of bachelor of science in entomology. The chief purpose of the course is to train students for the increasing demand coming from various government bureaus, experiment stations and from state and local health boards for advisers and investigators. The university has also established two new combination courses between the College of Arts and the College of Agriculture and designated them arts-culture and arts-home economics courses. The student is registered the first three years in the former college and the last two years in the latter. At the end of the fourth year the degree of bachelor of arts is granted and at the end of the fifth year the degree is either bachelor of science in agriculture or home economics.

Dr. H. W. Loeb has been made dean of the St. Louis University School of Medicine. In addition to the appointments of Dr. A. G. Pohlman and Dr. Don R. Joseph, already noted here, to the chairs of anatomy and physiology, Dr. Albert Kuntz, formerly instructor in the University of Iowa, has been appointed assistant professor of experimental biology.

Professor Ralph S. Lillie, of the University of Pennsylvania, has been elected head of the biological department of Clark University to succeed Professor Clifton F. Hodge, who has gone to the University of Oregon.

Dr. N. J. Lennes, of Columbia University, has been appointed professor of mathematics in the University of Montana.

In the department of biology and public health of the Massachusetts Institute of Technology Mr. Robert Spurr Weston has been appointed assistant professor.

Recent appointments in the University of California include the following to positions in the citrus experiment station and graduate school of tropical agriculture, located at Riverside, California: Dr. J. T. Barrett, pathologist of the University of Illinois, has been appointed professor of plant pathology; Professor H. S. Fawcett, pathologist of the California State Department of Horticulture and formerly pathologist of the Florida Experiment Station, has been appointed associate professor of plant pathology; Dr. Howard B. Frost, assistant in plant-breeding, Cornell University, has been appointed an instructor in plant-breeding.

At Grinnell College Dr. Leonidas R. Littleton, instructor in chemistry, has resigned to accept the professorship of chemistry at Emory and Henry College. He has been succeeded by William A. Ziegler, A.B. (Grinnell, '10), A.P. (Oxford, '13), a Rhodes scholar from Iowa. Dr. Louis D. Hartson has been promoted from instructor to assistant professor of psychology and education.

During the absence of Dr. David Hilt Tennent, who is on a Carnegie Research Expedition, Dr. Florence Peebles is taking charge of his work in Bryn Mawr College. Dr. Peebles, who was last year fellow of the Association of Collegiate Alumnæ, has just returned from a year abroad, where she carried on investigations in the marine laboratories at Naples and Monaco, and also in the University of Freiburg in Breisgau.

At the University of Wisconsin Dr. A. S. Pearse has been promoted to be associate professor of zoology.

At the University of Chicago Professors G. A. Bliss and H. E. Slaught have been promoted to full professorships of mathematics.

Dr. J. G. Fitzgerald has resigned as associate professor of bacteriology in the University of California and has been appointed associate professor of hygiene in the University of Toronto.

Dr. T. Franklin Sibly, lecturer in geology at King's College, London, has been appointed professor of geology in the University College of South Wales and Monmouthshire, Cardiff.

DISCUSSION AND CORRESPONDENCE

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES

To the Editor of Science: Your article "Doctorates conferred by American Universities" (Science, No. 973) is a valuable statement of facts from which you have wisely refrained from drawing conclusions. I fear that many of your readers will take it almost as a matter of course that those institutions which confer the largest number of doctor's degrees are the ones which are doing most for the highest education and for the progress of scholarship in America. This inference is not merely erroneous but is distinctly harmful. It is true that those institutions which succeed in collecting the largest number of students with the capacity and preparation necessary for doing work to some slight extent original, and which have teachers able and willing to inspire their students with the desire to do productive work are contributing most to the scientific advancement of the country. It is also true that *other things being equal* such institutions will produce each year the largest numbers of doctors. There is, however, another element of fundamental importance which is too often left out of account. The level of attainment and capacity of our doctors is, on the average, below that of German doctors, and these latter stand far below the doctors of several other European nations, such as France or the Scandinavian countries. In these latter countries the holder of the doctor's degree may, to use your phrase, be said to be "officially certified as competent to undertake advanced teaching and research work." In Germany and in this country such a statement must be taken in a decidedly Pickwickian sense, most doctors there being quite unable to stand alone scientifically. This is of less consequence in Germany, where the keen competition of the best doctors for academic promotion gives a sufficient incentive to further development beyond the usually rather low level of the doctor's degree. In this country such incentives are to a large extent lacking, and it is the duty of the strongest universities to raise the level of the doctor's degree distinctly above the standard set in Germany. Some of our strongest institutions are aware of this fact and try, even if as yet only in an uncertain and halting manner, to perform this duty in spite of the competition of the weaker institutions, some of which are glad to give the degree to men of doubtful qualifications. To expect uniformity of standard here would be Utopian; but it is important that in judging the relative success of different universities the quality of the output be given at least as much weight as the quantity. I, for one, hope the time is still very far distant when as large a proportion of our population take the doctor's degree as is the case in Germany.

Maxime Bôcher

Harvard University

AIR IN THE DEPTHS OF THE OCEAN

Several months ago three communications relating to the manner in which the water in the depths of the ocean is aerated, appeared in Science[1] and a recent review[2] of them has served to call attention to this subject again. Before the question is finally dismissed it may be worth while to point out that the single factor, namely, diffusion, suggested in these articles as the sole agent involved, plays only a negligible rôle in the process of aeration. The atmospheric gases diffuse very slowly through water, the coefficient of nitrogen being 1.73, of oxygen 1.62, and of carbon dioxide 1.38. The rapidity with which oxygen is transferred is well illustrated by Hüfner's[3] computations for the Bodensee, which has a maximum depth of about 250 meters. His results show (1) that it would take oxygen about forty-two and a third years to pass from the surface to the bottom of this lake by the process of diffusion alone; (2) that it would take over a hundred thousand years for the quantity of oxygen which its waters at a temperature of 10° C. are capable of holding, to diffuse into a body of water of equal area and unlimited depth; (3) that, under natural conditions, with the depth limited to 250 meters, it would require over a million years for this body of water to become saturated at the above temperature if it had no

1 Vol. XXXIV., pp. 239, 562 and 874.

2 *Internat. Revue*, Bd. V., p. 448.

3 *Arch. für Anat. und Physiol.* (Physiol. Abteil.), 1897, p. 112.

dissolved oxygen and acquired a supply only by diffusion from the atmosphere.

If ocean waters were aerated solely by diffusion from the atmosphere we should expect the upper strata to possess a larger amount of dissolved oxygen than the lower. But such is not the case in the tropical Atlantic, for instance. Here the smallest amounts, one to two cubic centimeters per liter of water, are found between the depths of 150 and 800 meters, while the water between 1,100 and 1,500 meters contains twice as much or more, that is, three to four cubic centimeters per liter.[4]

The Black Sea affords an excellent illustration of the inefficiency of diffusion in the process of aeration. Owing to the greater salinity, hence greater density, of the lower water the vertical currents do not penetrate to the bottom of the sea; that is, the lower portion is permanently stagnant and oxygen can pass into it only by diffusion. But Lebedinzeff[5] found no dissolved oxygen below a depth of 200 meters, the aerated portion comprising only about eight per cent. of the maximum depth of this body of water.

Similar conditions are found in many freshwater lakes during the summer period of thermal stratification. At this time the cool lower stratum of water is cut off from contact with the air by the warm upper stratum and can receive new supplies of oxygen only by diffusion from the latter. If the former loses any or all of its dissolved oxygen during the stagnation period, however, the deficiency continues until the autumnal overturning takes place.[6]

In view of these facts it is evident that some agent other than diffusion is responsible for the aeration of bodies of water. In lakes aeration is accomplished by the vernal and autumnal overturning of the water and its subsequent circulation for a longer or shorter period. In speaking of the aeration of ocean waters Helland-Hansen[7] states that "these gases are absorbed at the surface from the atmosphere and are carried by currents even into the deepest parts of the ocean in varying amounts."

C. Juday

[4] Schott, "Physische Meereskunde," p. 72.

[5] "Aus der Fischzuchtanstalt Nikolsk," No. 9, p. 113.

[6] Birge and Juday, Bull. XXII., Wis. Geol. and Nat. Hist. Survey.

[7] "The Depths of the Ocean," p. 253.

AN ANOMALOUS EFFECT OF RÖNTGEN RAYS

An unexpected effect due to X-rays has been brought to my attention, which I believe has been hitherto unobserved. The result is obtained as follows:

Let a sensitive plate be placed film down upon a silver coin, and let a second silver coin be so placed above the plate that areas of contact of the plate and coins partially overlap. Now let the plate and coins which are enclosed in a light-tight box be exposed to X-rays from above.

When the plate is developed, the result is of course a light area with but little effect due to radiation transmitted by the upper coin and a dark area due to the secondary radiation from the coin below. The anomaly appears at the area of overlapping coins. Since this receives its impression both from transmitted rays and from the secondary rays from the coin below, it is to be expected that this area will be darker than the remaining area shaded by the upper coin. The opposite is true, and the area of the overlapping coins is always lighter, *as though the secondary radiation from the lower coin cancelled the effect of the rays transmitted by the upper coin.* When small plates of lead are substituted for the silver coins, the effect is reversed, and the area in question is *darker* instead of lighter. This is the result that one would expect.

The writer has tried many combinations of metals in this manner and has found that the anomalous effect occurs in a number of cases, as for two gold coins, copper coins, gold and silver, and many others.

The question which the case suggests is in regard to the manner in which the neutralization of the effect of the transmitted rays is brought about by the secondary rays and why it seems to be so complete in some cases and not in others. The writer has tried to ascer-

tain whether the exposure of the plate to the transmitted rays and to the secondary rays must be simultaneous, but has been unable to produce the anomalous effect by successive exposures, that is, by an exposure first with the upper coin in place followed by another exposure with this coin removed and the lower coin in place. No vestige of cancellation could be found.

F. R. Gorton

THE ACID SPOTTING OF MORNING GLORIES BY CITY RAIN

That the trees, shrubs and flowering plants in our large cities and in the country along our trunk-line railroads are subjected to conditions which cause unhealthy growth and disease has been proven abundantly. Large factories, power plants and railroad locomotives are pouring out volumes of smoke, which alone is highly injurious, but in addition the acid which is formed in the combustion of coal, when dissolved in rain water, has injurious effect upon foliage and other plant parts. Its action is seen in the corrosion of tin roofs, rain pipes and ornamental iron work about city houses.

The following note is of interest to the plant pathologist and plant physiologist. During the night of September 19, 1913, a light rain fell, followed by a fine drizzle in the early morning of September 20. The wide-open campanulate flowers of the common morning glory (*Ipomœa purpurea* Roth), growing on a lot in West Philadelphia, four or five blocks from the Pennsylvania Railroad, had their usual quota of raindrops studded over the upper, inner surface of the purple corollas. Wherever the drops touched the surface of the corolla, the purple color was changed to a pinkish red, and in the process of evaporation of the raindrops the acid of the drops was concentrated, so that after the complete disappearance of the drops a brown spot was left in the center of the pinkish red circles of discoloration. The explanation of the alteration of color is found in the change of the sap of the corolla cells, where touched by the acid raindrops, from an alkaline to an acid reaction. A similar change can be induced in blue violet petals by bruising them slightly and placing them in an acid liquid. The petals change, like blue alkaline litmus paper, from blue to red, and this reaction with violet petals has proved useful in the physiologic laboratory in the absence of litmus paper. In nature a reverse change, which illustrates the same chemic principle, takes place in many flowers of plants belonging to the family Borraginaceæ. For example, in *Symphytum* and *Mertensia,* the red flower buds, the cells of which have an acid cell sap, gradually change to blue as the flowers open. That this is a chemic change is proved by treating the red buds with an alkaline fluid and the blue flowers with an acid one.

Similar spotting, but less clearly discernible and demonstrable, as the delicate reaction with morning-glory flowers, undoubtedly occurs on leaves and fruits, and the suggestion is made here, that such spots caused by the acidity of raindrops serve repeatedly as the points of entry of parasitic fungi, for there are many leaf spots and fruit spots that show concentric rings of diseased tissue in the earliest lesions produced. A fungus, which is stimulated to growth by an acid condition of the cell sap, would find ideal conditions for the commencement of growth by entering areas influenced by acid raindrops.

John W. Harshberger

University of Pennsylvania

SCIENTIFIC BOOKS

The Genus Iris. By William Rikatson Dykes. With forty-seven colored drawings by F. H. Round, one colored plate of seeds by Miss R. M. Cardew and thirty line drawings by C. W. Johnson. Cambridge, at the University Press. The University of Chicago Press, Chicago, Ill. 1913. Demy Folio. Pp. viii + 246. Price £6, 6s. net.

Thirty-six years ago J. G. Baker published his "Systema Iridacearum" in the *Journal of the Linnean Society,* including a revision of all the genera of the family. In this paper the genus *Iris* was made to include 81 species, distributed among six "sub-genera," namely, *Apogon* (33 sp.), *Onocyclus* (5 sp.), *Evansia*

(6 sp.), *Pogoniris* (31 sp.), *Hexapogon* (2 sp.), and *Dietes* (4 sp.). The genera *Xiphion* and *Juno*, excluded by Baker but since merged in *Iris*, included nearly 20 species, so that at that time the known plants now regarded as species of *Iris* reached about 100. A few years later (1892) when Baker published his "Handbook of the Irideae" the number of species was increased to 161, distributed among ten "subgenera" as he continued to regard them, as against six in his earlier treatment. Comparing Baker's disposition of the species with that of Dykes the greatest difference is to be found in *Pogoniris*, to which Baker assigned 52 species, while the later author assigns to it but 34 species. *Xiphium* with 14 species in Baker's "Handbook," has but 6 in Dykes's book. In some cases the later author has been unable to identify certain old names, while in others he has reduced them to synonymy.

American students have found Hasselbring's article "*Iris*" in Bailey's "Cyclopedia of Horticulture" very helpful. His treatment follows the general lines laid down by Baker, and includes 102 species.

Coming to the book before us one finds a far fuller treatment than had previously been accorded these plants, for here we have a botanical monograph of a generous type, in which there is successfully combined accuracy of scientific detail with popular directions to growers. To these matters of fact are added the exquisite colored drawings and fine printing and binding which make this a work of high artistic merit.

The botanist will notice that the author divides the genus into twelve sections, approximately equivalent to Baker's "subgenera." In eight of these the underground portion of the plant is a rhizome, while in the remaining sections it is bulbous (a bulb or corm). This character at once divides the genus into two parts—the "rhizomatous *Irises*," and the "bulbous *Irises*," and after this the sections are distinguished by their "smooth," "crested" or merely "bearded" outer segments (falls), and the seed characters (arillate, non-arillate). One third of the species (49) are found in the section *Apogon* with rhizomatous plants, and smooth falls, and nearly one fourth (34) are in the section *Pogoniris* with rhizomatous plants, and bearded falls. In the first of these are *Iris versicolor*, *I. missouriensis*, *I. montana*, *I. verna*, etc., while in the second are *I. pumila* and *I. germanica*, of our gardens. The sections *Onocyclus* (rhizomatous, with sparsely bearded falls; 16 sp.) and *Juno* (bulbous, with smooth falls; 17 sp.), include less commonly known species. The plants of the *Juno* section look very unlike ordinary *Irises*, their leaves being channeled, instead of sword-shaped, and the standards are spreading, instead of erect. In the *Onocyclus* section is found *Iris lortetii*, of the southern slopes of Lebanon in Palestine, "perhaps the most beautiful of all *Irises*." Its large flower is quite remarkable, with its nearly orbicular falls, orbicular, erect standards (3–4 inches in diameter) and arched, crimson-red styles. "Unfortunately it seems to be one of the most difficult to cultivate among the difficult members of its class."

This fine volume is destined to become the standard book on *Irises*, and on this account must be found in every botanical library, while its beautiful plates, fine paper, print and binding will cause it to find place in many private libraries.

CHARLES E. BESSEY

THE UNIVERSITY OF NEBRASKA

Thought and Things, or Genetic Logic. Vol. III., Part I. Real Logic. Interest and Art. JAMES MARK BALDWIN. London, George Allen and Company; New York, The Macmillan Company. 1911 Pp. xvi + 284.

This Part I. of Volume III. of Baldwin's "Genetic Logic" opens with a résumé of the conclusions of the other two volumes, "with a view to their bearing on the problem of reality." The "logic" of "affective experience" is discussed under the title The Logic of Practise, in Part III.; Esthetic Experience is discussed in Part IV.; The Modes of Immediacy are discussed in Part V.; and in a sixth part, the new term Pancalism (from the motto of the work as a whole, τὸ καλὸν πᾶν) is proposed as a name for the author's philosophy.

and a program is projected for another volume which will complete the work.

Perhaps the point of chief interest to the student of science in this volume is Baldwin's solution of the dualism of inner and outer controls developed especially in Volume II. It may be remembered that the actual and the imaginative are there contrasted with each other and traced to the external world, on the one hand, and to the self on the other. This knowledge and semblance "is the universal and ever-present contrast in the meanings of cognition." The imaginative rendering is always instrumental to the actual and the true. "We make-believe in order that we may believe." "The two controls (the inner and the outer) are now adjusted to each other through the mediation of ideas or thoughts." That is to say, the imagined or merely thought, under the inner control of the self, is instrumental to the attainment of truth. The work then distinguishes two sorts of knowledge to the attainment of which the imaginative is instrumental, namely theoretical knowledge and practical. Hence arises the question "whether there are other types of apprehension which either set up still further ends or in some way reduce or reconcile the duality disclosed by these two." To this question Baldwin replies, "There is a type of imaginative cognition, I wish at once to say, that does not allow of description under either of the two foregoing headings; a type which is motived not by the interest of completeness of knowledge or thought, nor yet by the interest of seeking satisfactions or working practical effects. There is a way of treating a content, usually and properly called 'esthetic,' that we may describe as both *over-logical* and *over-practical,* as not being strictly either of these, although involving both of them" (13). "The outcome of our investigation is that in the esthetic mode of experience so defined, we have the only inkling of the way that the self-reality of inner control which is the postulate of the practical and the worthful, and the thing-reality of external control which is the presupposition of knowledge and truth, *can in the process of experience come together after having fallen apart* in the development of cognition."

The last statement may be regarded as the main thesis of this third volume. It means that we are interested in practical and in theoretical knowledge because of a profound esthetic impulse which finds satisfaction now in the one and now in the other. The fundamental categories of the ethico-political consciousness as well as those of the scientific consciousness are esthetic. The objects of both kinds of knowledge are comprehended in a Whole beautiful which is known in contemplation. In that Whole both the self and the world of scientific knowledge find their fulfillment and satisfaction. It is their reality.

The intellectual project of this work, and its genetic method of investigation, are most interesting; but many will find difficulties in the final results. To the present writer, the dualism of inner and outer controls seems to be a presupposition of Baldwin's entire treatment of cognition, and consequently his esthetic experience, like Kant's purposive *Urtheilskraft,* can have only phenomenal validity. Moreover, we find Baldwin's discussion of the practical quite unsatisfactory. Does Baldwin mean that *practise* can be reduced to terms of knowledge-of-practise? The section on the "Logic of Practise" is devoted to the subject of affective logic, in the sense of Ribot, and we do not find in it a recognition of the world of human action with its rights and obligations, its freedom and responsibility. Finally, the question occurs to us whether Baldwin's beautiful Whole differs much, except in name, from Bradley's Absolute; for that also is a form of immediate experience. That method of Bradley's great book and that of Baldwin's are radically different, but are their results so far removed from each other as their methods?

G. A. TAWNEY
UNIVERSITY OF CINCINNATI

Lehrbuch der Algebra. Von HEINRICH WEBER. Kleine Ausgabe in einem Bande. Braunschweig. Vieweg und Sohn. 1912. Pp. x + 528.

Among the advanced text-books on algebra

there is probably none which is more favorably known than Weber's "Lehrbuch der Algebra" in three large volumes. The great extent of the work doubtless discouraged many beginners as well as those who have only time to learn the fundamental principles of this vast subject. Hence the small volume before us should find a hearty welcome among many students of mathematics who understand the German language.

The present book begins with a study of the elementary properties of determinants and their applications in the solution of a system of linear equations. The remaining fourteen chapters bear the following headings, in order: Numbers and integral functions, symmetric functions, roots, cubic and biquadratic equations, Sturm's theorem, approximation of the roots, groups, the Galois theory, cyclic equations, divisions of the circle, solution of the cyclotomic equation, algebraic solution of equations, numbers and functions of an algebraic realm, applications to cyclic realms.

From these chapter headings it is evident that the book under review is not confined to the most elementary matters, which can be found in nearly all the text-books on this subject. On the other hand, it does not presuppose very much, but develops from the beginning most of the subjects which it treats. As the book is a final effort, on the part of a great scholar and excellent writer, to present the main subjects of advanced algebra, it has a peculiar interest, both as regards the choice of material and the methods of treatment.

Although most students who are in position to profit much by the study of such a work can read German, yet there is doubtless a considerable number to whom an English translation would be very helpful, since there is no algebra in the English language which covers the same ground. The excellent "Introduction to Modern Algebra," by Professor Bôcher, for instance, does not enter into the Galois theory of equations and the theory of algebraic numbers—theories which occupy a prominent place in the present work.

In the preface it is stated that the author was assisted by his colleagues, especially by Messrs. Löwy, Epstein and Levi, while correcting the proof. These names, together with that of H. Weber, are a sufficient guarantee that no important errors appear in the book. Among the minor errors the statement that Dedekind first divided a group into double co-sets, which appears as a foot-note on page 196, is of especial interest. It is well known that Frobenius developed this method extensively in an article which appeared in *Crelle's Journal* in 1887, while Dedekind's article appeared seven years later.

G. A. MILLER

UNIVERSITY OF ILLINOIS

Measures of Proper Motion Stars Made with the 40-inch Refractor of the Yerkes Observatory in the Years 1907 to 1912. By S. W. BURNHAM. Washington, D. C. Published by the Carnegie Institution of Washington. 1913.

This handsome volume of iv + 311 quarto pages is so fully described by its title, given above, that comment upon it may be brief. To the astronomers of old time the stars were "fixed," *i. e.*, abiding eternally in the same celestial place without any trace of motion relative to their fellows. Less than two centuries ago, it was found that a few of the brighter stars appeared to be exceptional in this respect. Since increasing refinement of observation indicated a slow but continuous progression across the sky, peculiar or "proper" to a few stars that were forthwith assumed to be nearer than the others. The search for and determination of these proper motions has been one of the standard problems of astronomy since the time of Halley and the present volume is a contribution to that end. Its fundamental idea is that perceptible motion, being an unusual stellar attribute, may be assumed limited to the brighter stars and may be determined by measuring the change in the position of these exceptional stars by reference to any of the fainter ones about them. Possibly some suspicions with regard to the assumed fixity of the fainter stars finds expression in the author's introductory words, "It goes without

saying that every star in the heavens . . . must have some proper motion," but nevertheless he stoutly insists that for most stars this motion is of negligible amount, because the contrary has not yet been proved.

While the logic thus employed seems somewhat dubious, its quality need not be here too closely scanned. The present state of knowledge concerning stellar proper motions may be described as occupying intermediate ground between the fixity of the faint stars assumed by Burnham and his alternative proposition quoted above, which may be paraphrased into: Every star in the heavens does possess a sensible proper motion. The reviewer will undertake to show elsewhere that, at least down to the thirteenth magnitude, the latter proposition is more nearly true than is Burnham's assumption of fixity for the faint stars. If such be the case, the proper motions derived in this volume can command but little credence; they are quite futile, and the chief value of the work must be sought not in the fulfilment of its professed purposes, but in the furnishing of data from which the motions of the fainter stars may hereafter be derived when those of the brighter stars have been otherwise determined.

The as yet unborn investigator of stellar motions will find in this volume a rich store of material that he must use and will use for this purpose, albeit with writhings of spirit at the scanty information vouchsafed concerning its details, viz.: "These observations have been made in the usual way, fully described heretofore." The reviewer has not been able to find this description. He is left in doubt as to whether "the usual way" refers to observations of close double stars, such as have constituted the bulk of the author's previous work, or whether it implies that those modifications of program have been introduced that are required by the much greater angular distances between the stars here observed. How and with what precision was the parallel determined? How has the small, but troublesome, influence of refraction been dealt with? etc. These are questions that necessarily arise here, although of little consequence in ordinary double-star work. They find no answer in the text and, being unanswered, they must diminish the influence of the work and detract from the credence presumably due to its intrinsic character.

GEORGE C. COMSTOCK

SCIENTIFIC JOURNALS AND ARTICLES

THE articles in the *American Journal of Science* for October are:

"Distribution of the Active Deposit of Radium in an Electric Field (II.)," E. M. Wellisch.

"Adjustment of the Quartz Spectrograph," C. C. Hutchins.

"Stability Relations of the Silica Minerals," C. N. Fenner.

"Custerite: A New Contact Metamorphic Mineral," J. B. Umpleby, W. T. Schaller and E. S. Larsen.

"Ordovician Outlier at Hyde Manor in Sudbury, Vermont," T. N. Dale.

"Preparation of Tellurous Acid and Copper Ammonium Tellurite," G. O. Oberhelman and P. E. Browning.

"Determination of Water of Crystallization in Sulphates," S. B. Kuzirian.

"Paleozoic Section in Northern Utah," G. B. Richardson.

THE September issue of *Terrestrial Magnetism and Atmospheric Electricity* contains the following articles:

"Description of the C. I. W. Combined Magnetometer and Earth Inductor," J. A. Fleming and J. A. Widmer.

"Magnetic Declinations and Chart Corrections Obtained by the *Carnegie* from Port Stanley, Falkland Islands, to St. Helena and Bahia, February to April, 1913," L. A. Bauer and W. J. Peters.

"Magnetic Results of Halley's Expedition, 1698–1700," L. A. Bauer.

"Halley's Observations of the Magnetic Declination, 1698–1700," J. P. Ault and W. F. Wallis.

"On an Auroral Expedition to Bossekop, in the Spring of 1913," C. Störmer.

"Biographical Sketch of William Sutherland," E. F. J. Love.

"Results of Magnetic Observations Made by the United States Coast and Geodetic Survey at the Time of the Solar Eclipse of October 10, 1912," O. H. Tittmann.

Letters to Editor: "Principal Magnetic Storms

Recorded at the Cheltenham Magnetic Observatory," O. H. Tittmann; "The Magnetic Character of the Year 1912," G. van Dijk.

SPECIAL ARTICLES

TRANSFORMATION OF GRAVITATIONAL WAVES INTO ETHER VORTICES

On a number of occasions since 1890, when I first published my electrostatic doublet theory of cohesion, SCIENCE has been so good as to afford me the opportunity of making public the results of my investigations along this and other lines.[1] A brief account of some later work on the origin of vortex systems, accomplished during the past five or six years, may be of interest.

In the above-mentioned series of papers it was shown that all electrical and magnetic phenomena known could be mathematically derived from a system consisting of a single vortex filament in a frictionless fluid, and that gravitation was a compressional elasticity phenomenon in this fluid.

Now this single vortex filament, while satisfactory from the mathematical point of view, so far as all *known* phenomena go, is not equally so if, as we may suspect, the universe is conservative. There is a gap in the cycle. Also, while the single vortex filament appears to be forced upon us by the difficulty of forming any plausible idea of an action which would lead to a filling of the universe with a number of exactly similar vortices, yet if such an action could be formulated it would be more satisfactory, on the ground of probability, than the concept of the single vortex.

While still incomplete, the work above referred to as having been done since 1900, and mostly within the last five years, has given results which are quite satisfactory in regard to both the above-mentioned points. Put briefly, it would appear that gravitational waves shed off a portion of their energy as vortices, and that these vortices are of exactly similar nature irrespective of the intensity of the wave.

In my search for a satisfactory theory to account for the apparently exact similarity of vortex singularities in the ether I came again to Lord Rayleigh's discussion[2] of the difficulty in the equations for the propagation of plane sound waves (which difficulty was first pointed out by Stokes).[3]

According to these equations, the motion of a plane wave becomes after a time discontinuous. Stokes suggested (and Lord Rayleigh considered it probable) that some sort of reflection took place when the motion became discontinuous. Rayleigh also states that divergence would possibly prevent the occurrence of discontinuity, but my work seems to show that there is no beneficial effect caused by divergence; Rayleigh, Taylor and others have pointed out that viscosity would tend to prevent discontinuity.

Some time previously I had done considerable work, in connection with yacht designing, on the discontinuity of flow with the slipping of water along the side of a moving vessel; on the electromagnetic rotation of light in absorbing bodies;[4] and on the reflection of electric oscillations in electric wires with lumped capacity and inductance,[5] all of which work had at some point or other led up to discontinuities, when treated in the regular way, but all of which could be made to give, beyond the point of discontinuity, two part solutions, one part consisting of a diminished flow or wave intensity, and the other of an imaginary part which was interpretable as a vortex, sometimes oscillating, and sometimes conjoined with reflection.

This was at least suggestive, and on a careful examination of the difficulty referred to by Stokes and Lord Rayleigh in the equations for the propagation of plane waves, it was seen that the essential thing necessary to keep the wave from becoming discontinuous was that *it should shed off a certain fractional part of*

[1] "Further Developments of the Electrostatic Doublet Theory of Cohesion," SCIENCE, July 22, 1892, and March 3, 1893; "Determination of the Nature and Velocity of Gravitation," SCIENCE, November 16, 1900, etc.

[2] Rayleigh, "Sound," Vol. 2, p. 35.

[3] *Phil. Mag.*, November, 1848.

[4] *Phys. Rev.*, March, 1900.

[5] U. S. patent 706,738, 1901.

its energy, and that it did not matter how it did it, whether by viscosity or hysteresis or heat conduction or reflection or vortex motion. (I omit divergency because the only functions I can find connected with divergency which would prevent discontinuity either vanish at a short distance from the source, or only exist at the lateral edges of the wave, and hence do not affect spherical waves.)

Now in a fluid like the ether, viscosity, hysteresis and heat conduction losses can not occur. Nor, if my work is correct, can reflection occur without vortex motion, and then not necessarily.

But the vortex motion is a necessity, in a fluid like the ether, whenever a spherical wave reaches a certain distance from its source. And gravitational waves must therefore give rise to vortices in the ether.

And the satisfactory point about these vortices is that they are exactly similar, irrespective of the intensity of the gravitational wave, and dependent only upon the elasticity and density of the medium. This therefore relieves us of the necessity of assuming a single vortex filament.

There are some points still to be cleared up. For example, one might anticipate that the rotational velocity of the vortices would be the same as the translational velocity of the wave, but there appear to be at least one, and possibly two, other types, with rotational velocities of the square and cube root of the wave velocity; also in some respects the motion of what I have called the oscilla appear to differ from that of our standard vortex filament. All this is at present rather hard to interpret, but doubtless, as the difficulties of the analysis are gradually overcome, we shall be able to visualize the system more clearly.

As the work is still under way, the above results would not have been published but for the fact that it appears to have been generally assumed at the last British Association meeting that Planck's "quanta" theory and Maxwell's continuous medium theory are mutually exclusive and that one or the other must be given up. Now the results referred to above show that this is not so, but that every continuous medium theory *must* involve quanta, and we might almost say that a continuous medium begins to count as soon as it gets its legs. A unit quantity is, therefore, just as natural a thing as a flux; and in this connection it is interesting to note how, from Newton and Leibnitz down to Maxwell and Planck the English mind runs always to continuities and fluxes and the German to quanta and infinitesimals.

It may also be pointed out that quanta are a necessary consequence of motion due to central attraction. One visible example of this is the gaps in Saturn's rings. These are due to satellite resonance, but I have found that nucleus resonance gives quanta,[6] whether the resonant nucleus be the sun or the positive electron. The latter case is much the simpler, as all the corpuscles are the same size and so what we may call the "quanta orbits" are simpler.

From the above it will be seen that the problem of the transmission of plane waves in a frictionless fluid is not, as has been generally assumed, a matter of no practical importance and of interest to pure mathematicians only. But that it is a matter of very great practical importance, and that the complete solution of the problem is of capital importance in many fields, from the design of aeroplanes and the calculation of frictional resistance of ships to the theory of the constitution of the ether and the structure of the positive charge.

REGINALD A. FESSENDEN

THE SPECIFIC GRAVITY OF SILT[1]

IN a report recently published by the Department of State, entitled "Silt in the Rio Grande," certain fundamental ideas are promulgated, concerning the specific gravity of silt which seemed to the writer incorrect, and of sufficient importance to be worthy of a brief note in SCIENCE.

The author, W. W. Follett, consulting engineer of the International Boundary Commis-

[6] See also some of Darwin's papers.

[1] Published by permission of Director of the United States Geological Survey, Washington, D. C.

sion, and advisory engineer, commission for the equitable distribution of the waters of the Rio Grande, takes up the problem of how much space a given weight of river-borne silt will occupy when deposited in a reservoir, saying, on pages 11 and 12:

> It was evident that the per cent. of bulk, obtained from test tubes, would be too large for the desired unit because there was no weight on the silt in the tube to compact it, as there would be in a reservoir. . . .
>
> Something more than guesswork was wanted. It did not seem proper to us to found all our silt calculations on an assumed bulk for it which was, as it were, simply pulled out of the air. The desire was to approximate as closely as possible to the conditions which would be found in the bottom of a reservoir. After considering various schemes, to all of which there seemed to be valid objections, it was finally decided to seek a mud bar in the river where the water had been comparatively still and which had shrunk enough to show material cracks, and to cut from this bar a three-inch cube, have it dried out and weighed and to abide by the result, whatever it was. The idea was that a bar should be chosen which had shrunken enough to make up for the compression which the silt in the bottom of a reservoir would undergo from the weight of the water over it. Of course, the necessary amount of shrinkage could not be told exactly, but it was thought that a fairly good guess could be made.

The three-inch cube was collected, dried and found to weigh 85 per cent. as much as a three-inch cube of water. It was, therefore, assumed that "the above experiment fairly determined the weight of reservoir silt and that all silt determinations should be divided by 0.85 in order to obtain the actual final volume of the silt." The collection of the three-inch cube of silt is further described on page 75 of the report.

The first idea, which seems incorrect, is that deep water through its greater weight makes deposited silt more compact than shallow water. If the pores are filled with water, the pressure must be equal in all directions and the individual particles of silt being practically incompressible, the weight of the water must have negligible effect on the compactness of the silt. If the pores are not filled with water, but contain some air or other gas, the material would be compressed in proportion to the quantity of gas and the amount of pressure, but it does not seem probable that the compactness of silt is, in general, greatly affected by compression of included gases. It seems more reasonable to suppose that any greater compactness displayed by silt deposited in deep water is due to the arrangement of the particles or a modification of their form, brought about by the great distance traversed in settling, and especially is this true unless it can be shown that such silt expands when taken out of the water.

The second somewhat surprising idea is that one three-inch cube furnishes a better basis for determining the specific gravity of Rio Grande silt than all other available data, both inferential and experimental. If this be correct, there is certainly great need of adding to the available data, for the determination concerning the three-inch cube seems to be a small foundation for the argument and hundreds of computations which are based upon them. The result obtained, namely, that silt free from water weighs only 53 pounds per cubic foot, is considerably below most estimates and means that the material has a pore space of nearly 68 per cent.

E. W. Shaw

ON PSYCHOLOGY AND MEDICAL EDUCATION[1]

Following the symposium on psychology

[1] Report of the Committee of the American Psychological Association. The committee was constituted as follows: Shepherd Ivory Franz, scientific director and psychologist, Government Hospital for the Insane, and professor of physiology, George Washington Medical School, chairman; E. E. Southard, professor of neuropathology, Harvard Medical School, and director of the psychopathic department of the Boston State Hospital, and J. B. Watson, professor of psychology and director of the psychological laboratory, Johns Hopkins University. The scope of the inquiries of the committee was determined by the committee; the present report was written by the chairman, who is responsible for its form and the accuracy of its parts, but all the members of the committee are in accord with the conclusions.

and medical education[2] before the American Psychological Association in December, 1911, a committee was appointed to investigate and to cooperate with other bodies interested in this matter. The first part of this work forms the basis of the present report.

The committee sent to all the known medical schools in the United States and Canada inquiries which would lead to an understanding of the present belief regarding the advisability of including psychology as a required subject for medical students, and which would, at the same time, give facts regarding the teaching of allied subjects in the medical schools. Many of the institutions addressed did not reply to the first letter, and five months later, a second letter, incorporating the same questions, was sent to each school in the United States, which had not previously replied.[3] From the 116 schools in the United States, answers were received from 24 class A+;[4] 31 class A; 11 class B, and 5 class C—71 in all, or 61 per cent. of the total. Answers were not received from a number of the medical colleges which had decided to merge with others or to discontinue, or which are not in good standing with their respective states. These include 3 class A (Baltimore Medical, University of Maryland and Drake); 3 class B (University Medical of Kansas City, Kansas Medical and Birmingham Medical); and 7 class C (Jenner Medical, Herring Medical, Eclectic Medical of Kansas, Ensworth Medical, Willamette Medical, Wisconsin College of Physicians and Surgeons and Milwaukee Medical). In addition, one class C college (Ecletic Medical of New York) advised us of its suspension. Assuming that these institutions would have no special interest in the matters of which we inquired, or, on account of merging or discontinuation, could not give definite answers to the questions, it leaves 102 American medical colleges from which answers to our inquiries might have been expected. The total of 71 answers represents, therefore, replies from over two thirds of the presumably active medical schools in this country. In many cases, individual questions were not answered by the medical college authorities and only in a comparatively few cases were the replies full and complete. It is a notable fact that the full answers were received mainly from class A+ medical colleges, which, as is well known, are integral parts of universities. With but few exceptions the answers from B and C medical colleges were most unsatisfactory as regards completeness.

TABLE I

Classes of Schools Answering Inquiries

Classes	Total Numbers	Answered	Suspended, Merged	Per Cent of Expected Replies
A+	24	24	0	100
A	41	31	3	82
B	24	11	3	52
C	27[5]	5	8	26
Totals	116	71	14	70

The accompanying table shows the numbers of medical schools of the different classes, the number in each class answering our inquiries and the number of replies in each class which was not expected on account of mergers, etc., as indicated above. This table is an important indicator of the quality of the data used in making up the present report. Since the committee did not ask for the privilege of printing under the individual school names the data and opinions furnished to it, an arbitrary number has been assigned to each reporting school, from *1* to *24* to class A+ schools; *25* to *53* and *70* and *71* to class A schools; *54* to *64* to class B schools, and *65* to *69* to class C schools.

[2] *Jour. Amer. Med. Assoc.*, 1912, Vol. 58, 909–921.

[3] Two schools were not written to because their names and addresses were unknown to the committee at the time of the sending of our letters (Southern College of Medicine and Surgery of Atlanta, Georgia, and Chicago Hospital College). No replies were received from the eight Canadian medical colleges.

[4] The classification of schools in the present report has been taken from the "Classified List of Medical Colleges in the United States," revised to April 1, 1913, by the Council on Medical Education of the American Medical Association.

[5] Two others not written to (see above).

We wish to express our appreciation to the deans and professors of these medical schools for their replies, which were often extensive and showed painstaking interest. Without the cooperation and interest of these medical school officials, the present report would not be possible.[6]

The committee requested information along five lines. The special questions which were asked are given below as the heads of the individual sections of the report. It will be noted that matters regarding which inquiries were made were not entirely or strictly psychological. Since psychology has many connections with, and the understanding of many of its topics or divisions depends upon a certain amount of knowledge of, anatomy, physiology, pathology, neurology and psychiatry, the inquiries were broad enough to include information regarding certain aspects of these courses so that there might be considered the possible relations they might have to instruction in psychology. The inquiries were also made broad because the general medical conception of psychology is not that of the professional psychologist and psychiatrist, as some of the answers showed. In fact in some answers a very narrow conception of psychology was indicated; this, too, by men, well known in their own special fields, who were apparently laboring under the belief that psychology is the equivalent of "psychoanalysis" or some other equally restricted part of the whole.

[6] A list of the medical schools which did not answer the two letters of inquiry which were sent to them is of some interest, since in general it would appear to indicate a lack of interest on the part of these school authorities (there may be exceptions) in educational topics which have more than local application. It is notable that all of class A+ answered our letters. The A class schools which did not answer are: Jefferson, Meharry, University of Louisville, University of Mississippi, University of Vermont, Vanderbilt University, Wake Forest Medical Schools. Of the B class, the following: Atlanta School of Medicine, Baylor University, Chicago College of Medicine and Surgery, College of Physicians and Surgeons of Los Angeles, Detroit College of Medicine, Eclectic Medical College of Cincinnati, Hahnemann Medical College of Chicago, John A. Creighton Medical College, University of Arkansas, University of Oklahoma. Of C class, there were the following: College of Physicians and Surgeons of San Francisco, College of Medical Evangelists, California Eclectic Medical College, Georgia College of Eclectic Medicine and Surgery, American Medical of St. Louis, Kansas Hahnemann Medical College, Cotner University, Toledo Medical College, New York Medical College for Women, Leonard Medical College, Cleveland-Pulte Medical College, Fort Worth College of Medicine, Lincoln Memorial University, University of West Tennessee. Some of these schools have more recently announced discontinuation.

1. What amounts of time and what proportions of the courses in anatomy (including histology), physiology and pathology are devoted to the nervous system?

The individual answers to this question were on the whole unsatisfactory. Many of the colleges reported the numbers of hours without the percentages, others gave the percentages without the numbers of hours, and in only a few cases was the information complete. A tabular account of the answers is given in the accompanying table (Table II.).

TABLE II

Average Amounts and Proportions of Courses devoted to the Consideration of the Nervous System

	Hours	No. of Answers	Percentages	No of Answers
Anatomy	123	26	17.5	17
Physiology	71	31	22.5	22
Pathology	30	22	12.3	18

In this table the data are grouped irrespective of the fullness of the answers. For example, all answers which gave the total time for the consideration of the nervous system are grouped, and all those which gave proportions.

Anatomy of the Nervous System.—Only 12 schools gave both hours and percentages for anatomy and histology, and when these schools are considered apart, it is found that they average for the nervous system, 127 hours, or 14.5 per cent. of the average total time devoted to these courses. The average total for these 12 schools is, therefore, not far from the

general average of the 26, but the average percentage is much less. The variation from the average percentage (about 20 per cent.) is probably due to the fact that the 5 other schools reported their proportions in round numbers, as one fifth, one quarter, one third, and these should probably be considered estimates and not actual reports. It is important to note that the actual variations are considerable, the lowest numbers of reported hours being 54 (*26*),[7] 55 (*30*) and 60 (*43*); the highest, 246 (*53*), 192 (*6*) and 185 (*16*). The percentages also vary greatly; from 8 (*43*) and 9.1 (*1*) to 33.3 (*33*) and 32 (*5*).

It is possible that the different schools have not reported or estimated amounts of time for the same thing. It appears improbable that only 55 or 60 hours are devoted to the anatomy of the central and peripheral nervous system, as have been reported, and it does appear probable that in the schools reporting the lowest number of hours, no estimation has been made of the time devoted to dissection of the peripheral nervous system or to the special sense organs. While the last statement should not be considered as one of fact, it seems to us that the understanding of the connotation of the term "nervous system" varies from school to school. It is impossible to make allowances or estimations for the possible lack of understanding of the broad term which we used, but we believe that it would be safe to add at least 30 hours to many of the lowest estimates, and these additions would increase the general average by about 15.

Physiology of the Nervous System.—Thirteen of the schools reported less than 50 hours devoted to the physiology of the nervous system, 12 from 51 to 100 hours, and only 6 reported 100 hours or more. The lowest totals were 18 (*28*) and 20 (*48*); the highest were 150 (*13*, *30*) and 139 (*58*). The percentage variations were from 11 (*34*) to 45 (*5*). Eleven schools reported both amounts of time and proportions; these averaged 64 hours and 23.4 per cent., which are close to the general averages noted in Table II. Some of these wide variations are also probably to be explained by differences in conception of what was meant by the term "nervous system." It is not reasonable to suppose that a department of physiology devotes, as was reported by school *2*, only 22 hours out of 194 to this subject, which, if considered to include only the central nervous system and the special senses, takes up one third or more of the space of our modern text-books of physiology. On the other hand, it must be remembered also, as several answers indicated, that the time devoted to such topics as the nervous control of respiratory and intestinal movements can not readily be calculated. A careful count of two widely used text-books of physiology shows that, leaving out the parts devoted to the general physiology of muscular contraction, but including those dealing with the general physiology of nerve and the nervous control of various organs, the total physiological text-book consideration of the nervous system is from 39.5 per cent. to 32 per cent. When it is realized that in most medical schools there are separate departments of physiological chemistry, and that the two books examined give, respectively, about 4 per cent. and 18 per cent. of their space to this matter, it appears probable that there has been a tendency on the part of the medical school officers to make an underestimation of the time given to the nervous system rather than the reverse.

Moreover, the inclusion of pharmacology with physiology was not thought of by the committee, but it is apparent that in many institutions the study of the effects of drugs on the nervous system receives considerable attention. In some schools pharmacology (or pharmacodynamics) is taught in combination with physiology, and, in fact, one school reported that of the time devoted to "physiology, pharmacology and physiological chemistry," 20 per cent. to 25 per cent. was given to the nervous system.

Pathology of the Nervous System.—From the data collected it also appears probable that under the term "pathology" different colleges include different courses. One school (*16*), for example, reported the proportion for the

[7] These italic figures, it will be remembered, refer to individual schools.

combined "course in pathology, bacteriology and hygiene." In seven cases in which information was given by which the total time of the course in pathology could be calculated, it appears that the total time devoted to pathology varies from 126 hours (*12*) to 316 hours (*47*), with an average time of 249 hours. It is certain, however, that in the course in pathology in some medical schools only the more general conditions are dealt with, and that lectures on the pathology of nervous diseases are given in conjunction with those on the clinical aspects. Because of the latter condition, in some of the replies it was stated that it was impossible to give accurate figures, or even to estimate the amount or proportion, of the time devoted to the pathology of the nervous system. From Table II., however, it will be noted that 22 answers were received giving the amounts of time, average 30 hours; and 18 giving the proportions of time, average 12.3 per cent. The variations from these figures are as extensive as in anatomy and physiology. The smallest amount of time reported to us was 5 hours (*30*), the greatest, 60+ hours (*15*). The smallest percentage was 2 (*42*), and the greatest, 25 (*27*). The seven schools which reported sufficiently full information for accurate calculation of total and proportionate times gave averages of 33 hours and 13.5 per cent.

Total Time Devoted to the General Study of the Nervous System.—By adding together the average amounts of time in anatomy, physiology and pathology, we find that approximately 224 hours are devoted to the general study of the nervous system. In most institutions, this is part of the first two years' work, and since the yearly total of hours is usually between 1,000 and 1,200, it is seen that practically one tenth of the total time during the first two years is devoted to discussion and laboratory teaching of this important system. For comparison with the sum of the average times given to the nervous system in the three subjects, the answers from 16 schools (9 A+, 5 A and 2 B) which gave the times for all three subjects are of interest. Although the schools varied from 109 (*26*) to 317 hours (*16*), the average, 214, approaches the above figures.[8] The possibilities which were noted above, of underestimation of time in regard to each of the three subjects, must also be kept in mind, and if our beliefs in this regard have any validity, it must be concluded that fully ten per cent., and probably as much as fifteen per cent., of the total time of the first two years in medical schools is devoted to the study of the nervous system.

From personal acquaintance with the content of individual courses in anatomy and physiology, it is certain that many lecturers in both subjects discuss psychological matters and an examination of text-books of physiology shows that a considerable part of the space devoted to the "physiology of the nervous system" deals with what is now recognized as psychology. In this connection it is only necessary to point out that the method of working of the cerebral cells is not understood and that, because of this, physiologists describe the mental changes which are concomitants of injuries to or destructions of cerebral cells and connections. In the teaching of the functions of the nervous system, and especially of those of the special sense organs, much psychology (sometimes antiquated, to be sure) is introduced in lieu of strict psychology.[9]

From knowledge of individual courses and text-books, the committee believes that at the present time there is more psychology taught in medical schools than the catalogues of the institutions, or the replies to our letters would indicate. Much of this is dealt with in the

[8] One school (*32*) reported a total in all three courses of 460 hours. This figure was not used in the above calculation because the amounts of time for the individual subjects were not noted.

[9] The committee does not wish to initiate a discussion regarding the boundaries between and the fields of psychology and physiology. It assumes a certain general agreement regarding these matters which may be expressed briefly by the statements that psychology deals with mental matters (sensations, associations, etc.) and that physiology deals chiefly with the activities of cells or organs, and the interrelations of these.

courses in physiology, but even in anatomy and pathology lecturers do not entirely confine themselves to the discussion of non-psychological matters. While it may be possible to teach anatomy, physiology and pathology without reference to psychological matters, in practise this is probably rarely done. In considering the present status of psychology in the medical curriculum, account should, therefore, be taken of the inclusion in anatomy of a modicum of psychology and in dealing with such matters as sensation, perception, etc., the lack of strict separation of psychological facts and theories from those of a physiological nature.

2. How far do the third (or fourth) year courses in nervous and mental diseases take up the biological sides of neurology and psychiatry?

From the answers which were received, it is apparent that this question was quite generally not understood. The fact that it was not understood does, however, give some information regarding the teaching of neurology and psychiatry. Of the 57 answers, 27 were "no"; 24 were of a doubtful character, and only 6 were definitely positive. Careful reading of the doubtful answers shows that 16 of these should be grouped with the definitely "no" replies. The fullest replies, which were received from the professors of neurology in schools *30* and *37*, indicate plainly that their teaching of psychiatry and neurology is broadly biological, and not the narrow clinical teaching which characterizes so many of these courses. It is also apparent that in a very large proportion of our medical schools, neurology and psychiatry are taught as clinical subjects—diseases are described, differential diagnostic signs are discussed and methods of treatment are suggested. The broader aspects of these subjects are apparently not even hinted at in many schools, although a superficial reading of many of the answers which were received might lead to the opposite conclusion. Thus we read:

"All work in neurology and psychiatry is biological. I know of no other kind" (*25*); "Three months" (*57*); "15 lectures" (*66*).

It will be appreciated that answers such as the latter two indicate either a lack of understanding of what is meant by the "biological sides" of neurology and psychiatry, or there has been an unwarranted exaggeration of the amount of time given to this part of the subject.

3. Are there elective or graduate courses in medicine which deal with the relations of neurology, psychiatry and psychology, and how much time is given to them?

Only two schools (*3* and *23*) out of 60 which answered this question replied in the affirmative. School *23* reported an elective course, but gave no other information regarding it. School *3* reported a course of 6 hours on the relations of psychology and neurology. Another school (*4*) reported an "optional course, with interneship in hospital," and a fourth school (*43*) an "elective course of 32 hours, junior year." The remainder were negative.

It is apparent that students and graduates in medicine who incline toward practise in diseases of the mind and nervous system have few or no opportunities in the medical schools of this country to acquire a broader acquaintance with the subjects of neurology and psychiatry, than the clinical courses which are offered. It is also true that one seeking information regarding relations between such closely allied subjects as psychiatry, neurology and psychology must turn from the medical schools to some other source. At times, courses have been given in connection with psychiatric institutes or hospitals for the insane to fit their own appointees for the work they may be expected to perform, for it is notorious that the internes entering hospitals for the insane are not only ignorant of the facts of neurology and psychiatry and are unable to make diagnoses except in the simplest cases, but that at the same time they do not appreciate any of the possible interrelations of these subjects and that the burden of their special education must be borne by the older members of the staff. With the exception of an apprenticeship in a hospital for the insane, and this is not always adequate, there is at present no possible means of get-

ting an adequate conception of, and training for dealing with, the mass of nervous and mental disorders which is encountered in general practise.

When it is realized that the proportion of insanity is greater than 1:300 of the general population, it is a matter for wonder, and one which those interested in the proper preparation of and training of medical men should study carefully, that the medical schools do not offer adequate means for the acquirement of knowledge along these lines. When, to the number of insane there be added those whose mental conditions are not sufficiently abnormal to order their detention in a hospital for the insane, the wonder grows that the graduate of medicine is able to do more than to appreciate the fact that something is wrong with these patients when they consult him. In relation to the quantity of the physical diseases of the population, *i. e.*, total days of illness, it must be kept in mind that the proportion of the mental diseases is larger than 1:300, for this relation holds for three hundred and sixty-five days in the year. In view of the large proportion of insanity, and to this should be added the non-insane mental disorders and the nervous affections, it is not an exaggeration to say that the courses on insanity and neurology in medical schools are inadequate in time and usually quite unfit in character to prepare the student of medicine for this difficult part of his practise. The student is not prepared to appreciate what mind is, nor the conditions of its alteration, because his preparation in this particular is composed of a few didactic lectures regarding the forms of mental disease, perhaps a few clinical exercises in which patients are shown, and, if the conditions for teaching in hospitals for the insane are good, each student may have an opportunity to talk with a few cases of marked mental disease. At present the teaching of psychiatry appears to be in an earlier stage than surgery was in the two- or three-year course in medicine twenty years ago. How much longer will the medical schools keep psychiatry, neurology and psychology in these dark ages?

4. Is there any correlation or cooperation between the department of psychology in the academic department and the department of neurology and psychiatry in the medical school?

Three schools failed to answer this question in any manner; three others did not answer it because they were "two-year schools," but by their failure to answer for this reason indicated plainly that there was no cooperation or correlation between the medical work and the department of psychology in the college of arts and sciences. Eighteen other schools reported that they had no academic connections; thirty-three definitely reported no cooperation; one gave an unqualified positive answer and the remaining thirteen answered with more than a brief affirmation by giving indications of the character of the cooperation. Of the 52 schools which have affiliations, close or remote, with academic departments, only two sevenths report any form of correlation or cooperation with the department of psychology. Extracts noting the character of the cooperation between the department of psychology and the medical school follow:

"Men from the department of psychology . . . attend lectures and clinics of the professor of psychiatry"; also lectures on diseases of the brain (*1*).

Next year an instructor in psychiatry "is to give lectures on psychopathology in the academic department . . . otherwise, cooperation is unofficial though fairly strong" (*3*).

"The department of psychology . . . delivers a series of lectures in conjunction with the department of medicine and presents clinics at the insane hospital" (*4*).

"In the psychological department students take some work in the clinics" (*5*).

"Some coordination" but no cooperation (*6*).

"The department of psychology has affiliated all related branches in the medical department with a view of developing the fields cognate with the subject" (*i. e.*, irregular children) (*11*).

"The department of psychology . . . offers a special course for the medical students" (*21*).

"The psychology and physiology of the special senses is taught by a professor in the academic department" (*24*).

"None except to borrow apparatus" (*45*).

"Students are expected to select . . . one course in psychology during the preliminary year" (*46*).

"Psychology has been . . . placed in the second year of medical work" (*49*).

"Students in the two years of (premedical) work . . . are required to take two terms of three hours a week of general psychology. . . . Working upon the basis of closer contact and cooperation" (*50*).

It will be noted that not more than one half of these answers indicate any definite form of cooperation or correlation. At the most, the replies show that in some institutions academic students who are interested in psychological matters may attend certain courses in the medical school, and that in other institutions medical students are advised or compelled to take courses in psychology. It may be concluded that in this respect there is more promise than accomplishment.

5. In view of the increasing realization of the importance of the mental factor in medicine, is it your opinion that (*a*) it would be advisable to have given to the students special instruction in psychology, and, if so, (*b*) at what stage of the medical course would this instruction be best given?

Only 4 of the 71 medical schools failed to answer the first part of this question. The numbers and percentages of the different replies are as follows: 49 affirmative (73 per cent.); 8 negative (12 per cent.); 10 qualified affirmative or negative (15 per cent.). The percentages of affirmative and negative answers from the four classes of schools (A+, A, B and C) are approximately the same, being, respectively, 71, 72, 80 and 75.

After the first few answers were received, it was the supposition of the committee that those schools which had no academic connections would be less in favor of introducing into the medical school a subject which might necessitate the employment of a special instructor, but the full data indicate that the percentage (65) of affirmative replies from these schools varies but little from that (76) of the schools which have close academic ties. The answers to this question can not be well tabulated except in the rough form which is given above, but for an understanding of the beliefs regarding the advisability of introducing psychology into the medical school curriculum, or into the preparatory period of training, it is advisable to give brief extracts from some of the answers which were received. These will be taken up in the following order: negative, doubtful, affirmative.

In a few cases the negative answers were accompanied by some expression of view in addition to the simple "no." Some of these answers are interesting because of the apparent beliefs of certain medical men regarding the scope and recent developments of psychology, and are recorded here, because they serve to indicate that some of the apparent objections to the introduction of psychology into the course for medical students may be based upon ignorance or misapprehension of what the term psychology connotes.

"The professor of neurology . . . thinks it is a temporary fad which will be forgotten in a few years, just as electricity is now practically forgotten in the treatment of nervous diseases" (*1*).

"I doubt very much if information in formal psychology, I mean psychology in the older sense, is of very much use to the medical student" (*18*).

"I am not in favor of teaching psychology in the medical college. I believe that the wave of so-called psychology which has spread over medical literature during the past ten years is not worthy of the name and has been a distinct injury to medical science. It is in my opinion very erroneous and misleading. None more so than Dr. Morton Prince's and Dr. Freud's" (*25*).

The two following quotations are also of interest as negative answers:

"No unanimity of opinion among the faculty members. I personally am of the opinion that the experiment might well be tried by some of the larger university medical departments" (*20*).

"We do not think it would be advisable to include psychology in the medical curriculum. All of our students must be graduates in arts and sciences before entering the medical school and these courses usually include psychology, logic, philosophy, etc." (*2*).[10]

[10] In a conversation with the professor of psychiatry of this medical school, it was learned that this view was not the one held by him, and he

The following are some of the answers which, while not decisively positive or negative, but at the same time not favoring the introduction of psychology into the medical school curriculum or as a requirement for entrance, modify the statements in certain particulars.

"While we consider that it would be desirable to give special instruction in psychology, especially in the fourth year, we do not at the present time see how time could be found for it" (*12*).

"Yes; but it is hardly feasible in the immediate future" (*35*).

"It would be desirable for the students to be taught psychology, but on account of the fact that it is only a four-year course and other subjects being more important and requiring all the students' time, as the course is now arranged, it is not probable that we shall be able to establish a separate course in psychology. If it were introduced it would be best to have it in the third year" (*54*).

"I believe it is very undesirable to add more to the medical curriculum. . . . It seems to me that it would be better to urge students to study psychology in the premedical college course" (*19*).

"It seems doubtful if instruction in psychology can be introduced into the already crowded undergraduate course. Elementary instruction in psychology is desirable as a preliminary study, though it is not possible to require it at present. It is improbable that psychology can be introduced as a required subject. An optional course might be profitably given" (*22*).

"It would seem that nothing should be added to the medical course without an equivalent abstraction. . . . It seems as if psychology was necessary, and, in the light of my previous statements, it ought to be taught as a part of . . . preparation" (*36*).

"I consider it inadvisable at any time to touch more than lightly to the undergraduate body upon the question of psychology. It should, however, be touched, in my opinion, in the final year if taught in the regular course. Personally, I believe that it should be devoted to post-graduate work" (*32*).

"It would be unwise to add anything further as compulsory work. I think it well to give an optional or post-graduate course for students especially interested" (*40*).

"The medical curriculum is now overcrowded; this should be graduate work, in my opinion" (*45*).

reported that he did not believe it represented the attitude of the medical departments chiefly concerned. Since this report was typed, the secretary of this school has written correcting the above statement as follows: "As a matter of fact, Professor ——— is already committed to the advisability of extending his lectures by adding a sufficient course of instruction in advanced normal psychology from the medical standpoint, and the authorities of the college have already expressed their approval of his ideas in this direction." The percentage of affirmative answers is, therefore, increased to 75, and that of the negative answers reduced to 10.

Opposed to these negative and doubtful answers others of an equally positive nature have been received. Some of these are as follows:

"Psychology is a desirable study for medical students. Up to date I know of no course in psychology which is particularly adapted to the needs of the medical student. Could instruction in psychology be given by a trained psychiatrist rather than a pure psychologist, time could probably be found for such a course in the medical curriculum" (*6*).

"Instruction in psychology is not merely advisable . . . but necessary, and such instruction should be at least partially premedical, and should be developed practically and logically later in the medical course in the departments of neurology and psychiatry" (*8*).

"We have felt for a long time that psychology was most important as a preparation for the study and practise of medicine" (*9*).

"My observation in regard to those who write in medical journals on the subject (psychiatry) would seem to indicate that they had had no competent preparation in psychology. . . . I have recommended that one of the professors in the department of psychology who is trained in the physiology and pathology of the brain and nervous system give a course in the college of medicine preliminary to the study of psychiatry" (*10*).

"I thoroughly agree with the importance of special instruction in psychology in the broad scope which your inquiries would indicate and I should be glad to have any information which would lead to the possibility of the establishment of a systematic course in the subject" (*11*).

"The demands of modern medicine require an elementary course in medical psychology to be given in the medical department . . . (to) be carried out under the direction of the department of nervous and mental diseases. . . . in the second year after the work in anatomy and physiology of the nervous system" (*16*).

"Psychology is of such importance in medicine that a course in general psychology should be recognized as one of the fundamentals, and should be required as a part of the college work required for entrance. Further instruction in applied psychology should form a part of the clinical work in connection with mental and nervous diseases" (*17*).

"I believe that special instruction in psychology should be given medical students . . . (not) the traditional introspective aspects of the subject . . . but psychology for medical students ought to be as concrete and objective as possible" (*21*).

"I am decidedly of the opinion that students should receive instruction in normal psychology . . . such instruction should be given as part of the course in physiology in those institutions in which one of the professors in physiology were sufficiently familiar with the subject" (*58*).

It should also be noted that 10 medical schools have already introduced (or plan to introduce next year) psychology into the curriculum or require it for entrance, and one advises students to take a course in psychology in the preparatory premedical years. Quotations from these replies follow:

"In the . . . second year the students are to be given a course in psychology as an extension of their anatomical and physiological course in the medically important topics of psychology . . . in the . . . third year a course of . . . lectures and demonstrations covers the essentials of experimental and clinical psychopathology" (*5*).

"Psychology is recommended as preparatory to the study of medicine" (15).

"Beginning next year, psychology prescribed during second of the two collegiate years required for entrance" (*29*).

"Instruction in psychology is given to students in their second year of collegiate work. We hope to have a course in medical psychology for senior students" (*30*).

"Psychology has been removed from the second premedical year and placed in the second year of medical work" (*49*).

"A full course in physiological psychology extending throughout the year is given to the sophomores. . . .The course prepares the students for the instruction in neurology and psychiatry" (*56*).

"Ours (*i. e.*, course in psychology) is given during the latter part of the session, but it seems to me that a large (part of the) time that is devoted to pharmacology and materia medica could be more profitably spent in neurophysiology and psychology" (*62*).

"I give the students a preliminary course of normal psychology and then take up pathological psychology" (*64*).

"We have a course, 32 hours to sophomores, in psychology" (*65*).

"I have been teaching applied psychology . . . for the last three years . . . not . . . the usual psychology taught in academic departments, but psychology as it applies to the normal and then to the neurotic. . . . In my own opinion most of the so-called psychological courses given are worthless . . . purely academic in nature, and no application whatever is made to their every-day uses" (*70*).

Of the 49 schools which indicated their belief that psychology should be introduced into the medical curriculum, 47 have also indicated the position that such work should occupy. Of these schools, 27 advise that it be placed in the medical preparatory years or in the first two years of the medical courses, and the other 20 stated that it should be given in the final years. Most of the latter insisted that its place was a part of, or as a special preparation for, the work in nervous and mental diseases. Of the 27 schools which advised the introduction of psychology into the first part of the course or into the years of medical preparation, 12 refer, explicitly or by implication, to the dependence of psychology upon the facts of anatomy and physiology, and advise its introduction at a time when the courses in the anatomy and physiology of the nervous system are being given or after they have been completed. Although admitting its value, 4 would dismiss psychology by including it as a required course in the premedical years. The other 11 schools advise that a second course be given during the third or fourth years in addition to the require-

ment of the first years of the medical work. They would divide the instruction in psychology into two portions, the first to be offered to students during the first part (including the premedical years) of the medical course, the second during the last two years of the curriculum. In the first course in psychology only the general outline of the subject would be given, in the second particular attention would be paid to its "special medical meanings." The latter, dealing with the applications of psychology, would be given previous to, or coordinate with, the courses in clinical neurology and psychiatry.

Relative to the above results the committee may at this point answer a possible question regarding them. It may properly be asked if the results do not represent chiefly the opinions of professors of neurology and psychiatry, who are supposed to have a special interest in psychological matters, and not those of other members of the medical faculties. All of our letters of inquiry were addressed to deans or other administrative officers of the medical schools. In a number of instances the letters of the committee were transmitted to other members of the faculty for answer. It is probably due to this fact that in a number of cases complete answers were not received, for the member of the faculty to whom the letter was transmitted sometimes answered only that part relative to his department. In many cases the deans obtained the full information from the members of the departments concerned, and transmitted all information, at times with great fullness, to us. In the answers to our question 5, only 19 of the 67 replies were answers by, or contained quotations of opinions of, professors of neurology and psychiatry. An equal number were answers from the administrative officers, dean or secretary, whose special medical interests could not be determined[11] (but probably representing the views of their faculties). The remaining 29 were from deans and other administrative officers whose primary medical interests were distributed over a wide field; 4 in physiology, 4 in pathology, 11 in medicine, 1 in surgery, 1 in hygiene and 8 in anatomy. The decisively negative answers to this question were received from 5 professors of nervous and mental diseases, 1 of anatomy, and 2 administrative officers; the doubtful answers were received from 2 professors of nervous and mental diseases, 2 of anatomy, 1 each of physiology, medicine and pathology and 3 administrative officers; the positive answers were received from 12 professors of nervous and mental diseases, 5 of anatomy, 3 of physiology, 3 of pathology, 10 of medicine, 1 of surgery, 1 of hygiene and 14 administrative officers whose medical interests are unknown. If all the answers from professors of nervous and mental diseases be omitted because of possible professional bias, the percentage of replies in favor of the introduction of psychology into the period of medical training is 77, which, it will be noted, is slightly in excess of the general percentage.

[11] Catalogues of the institutions were not at hand, and reference was made to "American Men of Science" and to "Who's Who in America," 1912–13. The names of these 19 correspondents were not found in either directory.

From the facts which the committee has been able to gather, the following conclusions have been drawn:

1. It appears to be the preponderating opinion both of the best schools and of the schools as a whole, that some instruction in psychology is necessary so that students may understand the mental side of their patients, not only of those which are to be dealt with as insane, but also of many who never reach the extreme conditions which warrant their being sent to an institution for nervous or mental diseases.

2. By those medical schools which require for entrance a college education in arts or sciences, the committee believes that an introductory course in psychology may well be required, in the same way as they now require chemistry, biology, physics, etc. In those schools which do not require a preliminary college training but which require one or two years of college work, the committee believes that part of the premedical preparation should be devoted to general psychology, or in lieu

thereof, a course should be given preferably in the second year after the general work in anatomy and physiology of the nervous system has been completed. The committee believes that a briefer course following the physiology of the nervous system would be more desirable than a course in the premedical years. If the earlier course be more extensive and devote sufficient time to the functions of the nervous system, the advantage of the later course would be counterbalanced.

3. It is the belief of most of the best schools that a second course in psychology should precede the course in clinical psychiatry and neurology. This course should have more of a practical nature, and should deal especially with abnormal mental processes and with the application of psychological principles and facts to medical topics. Although this course should deal chiefly with psychopathology, it should not be permitted to develop, or degenerate, into a course in psychiatry, neurology or psychotherapeutics. This course should be clinical in the sense that, as far as possible, clinical material should be the basis of the course, but it should not be clinical in the sense that the students are given particular cases for the purpose of diagnosis or of treatment. The functions of the courses in psychiatry and neurology should not be assumed by this course.

4. Although, on account of their knowledge of the practical medical application, it might be best if both courses in psychology could be given by competent medical men, the committee feel that there are at present few medical men who have had sufficient training or have sufficient interest in psychology to warrant their appointment to initiate such work. It seems best, therefore, to recommend for those medical schools in which there is a possibility of correlation or cooperation with the department of psychology in the school of arts and sciences, that these courses be given jointly, and cooperatively, by the departments of psychology and psychiatry or neurology.

5. The content of the course or courses in psychology should be the object of careful consideration by representatives or professors of those subjects which are allied to psychology. The departments which should be chiefly consulted include physiology, psychiatry, psychology and neurology. It is the belief of the committee, however, that since the courses are intended for the preparation of medical men, the courses should be practical and should deal with actual medical facts as much as possible. The committee would not, however, limit the teaching in the elementary courses to those topics which have a known practical medical value at the present time, for it has always been found that facts apparently incapable of application at the time of, and immediately after, their discovery are soon applied. It is our belief, therefore, that the first course in psychology, as introductory to the study of medicine, should be a general course, dealing largely with general psychological facts, standpoints and methods, but that constant reference should be made to the practical problems which may be solved by means of the psychological methods and facts which are discussed. The committee also believes that both courses in psychology should be laboratory or experimental as far as possible, that the student may become personally acquainted with the methods and with the general nature of psychological experimentation, rather than obtain his knowledge from text-books. Although recitations or lectures have great value, they can not give an adequate knowledge of the manifold difficulties which one encounters in dealing with matters of a mental nature.

6. The committee also feels strongly that more extensive and intensive cooperation between psychologists and physicians is desirable. From the psychologist's standpoint the psychology of medical men is crude; from the medical standpoint the pathology and physiology of the psychologist are out of date. Since both classes have many common interests it would appear wise that the knowledge of psychologists should be utilized by physicians and that in turn the experience of more physicians might be made available for the advancement of psychology and psychopathology.

Shepherd Ivory Franz

SCIENCE

FRIDAY, OCTOBER 24, 1913

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

SOME RELATIONS BETWEEN PHILOSOPHY AND SCIENCE IN THE FIRST HALF OF THE NINETEENTH CENTURY IN GERMANY[1]

I PRESENT this paper in response to Dr. Councilman's request; and its choice of topics is determined wholly by the instructions that he has given me in asking me to prepare to meet you. It is not for me to judge in what way these hastily prepared notes can be of service to any of you; and as a fact, I confess myself unable to see that they can be of any service whatever to a company of pathologists. I am, of course, profoundly ignorant of pathology. And, as I learn from consulting the sources, the school of scientific men of whom Virchow was the leader felt, at the outset of their great undertaking, in the years before 1850, that philosophy, and, in particular, that what used to be called, in Germany, the *Naturphilosophie*, had formerly been, in the main, profoundly harmful in its influence upon medicine in general, and upon the beginnings of modern pathology in particular, so that one great initial purpose of Virchow and of his allies, during the years before 1848, was to free their young science from whatever was still left of these evil philosophical influences and to make it a true natural science. I not only learn that this was their opinion; but I see, as any student of the history of thought in the nineteenth century must see, that this opinion was in a large measure very well justified. Philosophy, in the first quarter of the nine-

[1] Read at a session of the Pathological Club, of the Harvard Medical School, at the request of Professor W. T. Councilman, President of the Club.

teenth century, in Germany, had done medicine a good deal of harm. The evil influence continued in some sense, although in much diminished degree, into the next decade or so. Yet I am now asked to tell you something about what this movement of thought called the *Naturphilosophie* was, and about what its relations to the natural sciences were up to, say, 1840. But what interest can you take to-day in the story of the evil influence of an enemy that is said indeed to have threatened the cradle of your infant science of modern pathology, but that very early lost all its power to harm. As a fact, the *Naturphilosophie*, viewed as an officially recognized tendency that could possess any strong direct influence in Germany, was very nearly dead before the great days of 1848 came. Since its death, the *Naturphilosophie* has seldom been mentioned by anybody except with contempt. Its later direct and overt influence upon the course of scientific discovery has been nothing. Nothing then that is of any critical importance to the later development of your science seems to be involved in the story that I have been asked to rehearse.

In fact, to speak in a figure, your science of modern pathology, as Virchow nourished it, proved to be a sort of Hercules. In his infancy this Hercules strangled various serpents. One of these is understood to have been so much of the *Naturphilosophie* as a hostile metaphysical power had sent forth to vex medicine, and as still survived to be strangled. Now the original Greek Hercules and his friends were no doubt always fond of telling over, in later years, the story about the strangling of the serpents by the infant. But I have not heard that Hercules and his friends ever put anybody into my present position by asking him to read them a paper on the natural history of snakes. I doubt whether either Hercules or his companions would have found such a paper interesting. Snakes, they would have said, are to be strangled, not studied. The difficulty of my own position in your presence to-night is of course further increased by the fact that I, who study philosophy, doubtless must seem to some of you to be myself a representative, in some sense, of the very generation of vipers in question. My task is therefore hard indeed.

One thing alone has given me the courage to attempt the enterprise. This is the fact that if the direct and easily visible influence of the *Naturphilosophie* upon the later growth of modern science was indeed small, its indirect and relatively invisible influence was probably large, while this latter influence was of a sort which not only may interest you, when I point it out, but which also probably determines some of your own scientific interests even at the present day. I can not show you then that the literal teachings of the *Naturphilosophie* accomplished much of direct moment or of critical importance for the science of that time. But I think that as a fact the spirit of the *Naturphilosophie* did enter, more or less unconsciously, and in ways which were not always evil, into the life of later scientific thinking. I do find that this spirit tends at the present time to be revived, and by some scientific men too,—to be revived, I say, in forms which, as I hope, will prove to be far nobler and more stable than were those which grew up in the first two decades of the nineteenth century. I see moreover that when we try to estimate what this more immortal part of the *Naturphilosophie* meant, we are led to certain considerations about the true spirit and methods of natural science,—to certain questions in which I, as a student of logic, am much interested, and in which, as I believe, you too may take some interest. And so, doubtful as

my task is, it is not wholly hopeless. Perhaps, after all, before I am done I may show you a few facts in which as students of the methods and of the general relations of your own science, you may find something that will be serviceable.

My plan will be this: First I shall sketch for you in the barest outline the external history of the movement called in Germany the *Naturphilosophie*—its rise, its brief success, its inglorious downfall and end. I shall lay stress, of course, on its relations to natural science, such as they were. Then, secondly, I shall try to indicate to you what the deeper ideas were which lay behind and beneath all the vanities and the excesses of the *Naturphilosophen*. Thirdly, I shall try to indicate how these deeper ideas, despite the vanishing of the *Naturphilosophie* from the scene, indirectly but seriously influenced the course of the later development of natural science in the nineteenth century, and how these ideas seem to be traceable even in some aspects of the history of your own science, so far as those aspects are visible to the layman. Fourthly, and lastly, I shall present to you the question whether some light is not thrown upon the logic of natural science, upon the ideals and methods of scientific work, by considering the relation between those deeper ideas that inspired the *Naturphilosophie* and the actual growth of scientific investigation in the years since 1840.

I

First then, for the purely external, and the least interesting aspect of our story.

At the opening of the nineteenth century, a very notable philosophical movement was under way in the thought of Germany. This movement had been initiated, in the years about and after 1780, by Kant—himself a man of considerable training in the physical sciences of his time, of considerable acquaintance also with the empirical study of human nature, and of a very sane, sober and critical judgment. Kant intended, amongst other things, to define and to formulate a philosophy of the principles and methods of the natural sciences. He succeeded so well that his ideas are still of great importance for any serious student of logic and of the theory of knowledge; and their value for such a student will not soon be exhausted.

But Kant's influence was not confined to the study of the foundations and methods of science. He still more immediately influenced his time with regard to questions of ethics, of theology, and of the more fundamental religious issues of life generally. As a fact, his age—which soon became the age of the French Revolution, and of the great classical literature of Germany, was in his country an age of the humanities, rather than of the natural sciences. His influence was therefore felt, at the moment, much more in the direction of the humanities, than in any other way. The philosophical movement to which he gave rise, accordingly, soon grew beyond what he had intended, and concerned itself with a constructive creation of idealistic systems of thought such as he himself considered unjustifiable. And in these systems, about and after the year 1800, the principal stress was laid upon what were essentially ethical and theological issues. The post-Kantian idealists conceived their philosophy as a sort of substitute for all that traditional religion had so far meant for the world, or at least as a discovery of the absolute rational warrant for new and higher stages of the religious consciousness. So a great part of their work had no direct relation to the business of natural science.

It came to pass, however, just before 1800, that one of the most enthusiastic of these young idealists, namely, Friedrich

Wilhelm Joseph Schelling, was led by motives, which I need not pause here to portray, to turn a large share of his attention to an effort to absorb into his absolute system an organized theory of the nature and meaning of the physical universe. Schelling called this portion of his doctrine the "Philosophy of Nature." That special use of the term *Naturphilosophie* with which we are here concerned was thus due to Schelling. It meant an interpretation of nature in the light of the principles of an idealistic philosophy.

Of Schelling's genuine significance as a philosopher this is not the place to speak. Of the man himself, a very general characterization is more possible. In 1800 he was twenty-five years of age. Yet he was already a professor at the University of Jena, to which he had been called in 1798 by Goethe's recommendation; and he was also, before the close of the eighteenth century, a celebrated man and a prolific author. He was, in this his decidedly wonderful youth, an intensely restless genius, all aglow with brilliant and often with very genuinely significant ideas—a man of a tropical intellectual fecundity, but also of dangerous self-confidence. In polemic he was merciless, in expression enormously complex, in literary form strangely unequal. The luminous and the hopelessly opaque stand side by side in his books in the strangest contrast. His industry was enormous, his sincerity unquestionable, his real power unmistakable, his waywardness exasperating, his frequent obscurity unpardonable, his contemporary influence vast, but most of his work, despite its frequent value, still far too unstable. He inspired a generation of young men, but did them little good that was at once direct and permanent. He wrote down some thoughts that deserve to be remembered for all time, yet so affected his contemporaries that the best of them later turned almost wholly away from him. He thus proved, in the long run, to be an irritant rather than an organizing power. His work was often like that of a whirlwind in the world of thought, disturbing, cloud-enshrouded, momentous, but dissatisfying. After 1803 he left Jena, lived long in South Germany, lost his place for many years as a leader of the national thought, passed through various periods of further philosophical development, lived to a stately and ineffective old age, came once more in 1841 into a brief prominence as a public lecturer in Berlin, but then, retiring yet again from public notice, died in 1854, nearly eighty years old. His published works number fourteen volumes octavo.

For our present purposes, in order to sketch the youthful Schelling's *Naturphilosophie* as he formulated it in the years about 1800, I shall content myself with the following· Certain reasons which I need not now try to portray, but which, in view of the history of human thought, are, to say the least, strictly intelligible reasons and which are in their true interpretation, as I myself think, quite defensible reasons, led Schelling to hold, as many philosophers had held before him, that the universe in which we live is in its inmost nature a single organized unity. In other words, Schelling was what you nowadays often hear called a monist. Moreover, Schelling was confident that philosophy, as it was in his time, was prepared to give a new and final interpretation of this unity of things. Now an account of the unity of the world would of course undertake to consider the problems of theology, of ethics, and of the philosophy of mind. But this same philosophical account, as Schelling held, would also include a discussion of the nature, the unity and the meaning, of the physical world. Such an account—such a philosophical theory of nature—as Schelling often and expressly

maintained, would be, in one aspect, an *a priori* theory, that is, it would be based upon the general character of our own knowledge of nature, and upon the demands which are made by our reason. For, as Schelling held, truth can not be accepted by us, unless we can recognize it as in some sense our own truth, the expression of our own rational demands. Great stress was thus laid, by the philosopher, upon the share which our own self-conscious insight has in defining for us the nature of things. It would be a mistake, however, to suppose that the youthful Schelling, even with all his enthusiasm, actually ventured to attempt to spin all the contents of his *Naturphilosophie* out of his bare and unaided inner consciousness. He was both ignorant and contemptuous of the well-disciplined procedure of the more abstruse experimental sciences; but he was not ignorant of the broader results which the natural sciences of his time reported; and he took considerable interest in these results. Moreover he was, in a way, an enthusiastic although very undisciplined observer of nature. His defect was thus not like the defect of a modern christian scientist who simply turns away from natural phenomena, and denying that they mean anything but mortal error, does indeed get a theory of nature only by means of deliberately ignoring natural truth. Schelling's defect was rather that of an esthetically minded enthusiast who revels in the study of a great variety of natural phenomena, but who undertakes to interpret these phenomena by means of personal intuitions. Meanwhile these intuitions themselves were, with Schelling, by no means those of a mere child, or of a savage, but of a wayward yet highly cultivated young man of the close of the eighteenth century. They were intuitions which presupposed, and undertook to interpret, the results of much miscellaneous reading, and of a good deal of undisciplined observation on Schelling's part relating to physical, chemical and biological facts and theories. You can not doubt Schelling's capricious but extensive industry in the study of nature. His fault lay in his self-assurance, in his impatience, and in his determination to tell nature at once upon meeting her precisely what she meant. Amongst his favorite classes of phenomena, about which he read and speculated, were those of electricity and magnetism, of chemical affinity, so far as these phenomena were then known, and of organic development. He was indeed far beyond the uncultivated fashions of interpretation which we know so well in ordinary cranks. Yet much of his work was as vain as circle-squaring in its actually resulting relation to any concrete business of natural science. Schelling had amongst other things a considerable and a somewhat mischievous interest in medicine. What now is called psychical research was a favorite occupation of the time; and that too won a good deal of Schelling's attention. In 1806, after Schelling had left Jena, he began to publish, in union with a friend and partial disciple of his, A. F. Marcus, a periodical called *Jahrbücher der Medicin als Wissenschaft*. Of this periodical three volumes appeared at Tübingen, the third and last in 1808. The articles to be found in it include an extensive series of aphorisms on the *Naturphilosophie* by Schelling, papers on animal magnetism by Schelling's brother (himself a physician), essays on the application of various metals (iron, mercury) in medicine by Marcus, papers on the relation of botany to medicine by Steffens, on inflammation by Marcus, and so on.

As the mention of this journal shows you, the *Naturphilosophie* of Schelling had from the first the tendency not to remain the expression of the individual philosopher, but

to form a school, to apply itself to various arts and sciences, to publish in journals special researches—in brief, to assume the outward seeming of a progressive and humane science. Ere long it had representatives, exemplifying various grades of discipleship, in academic chairs in Germany. To the young men who fell under its influence it sometimes meant, no doubt, a chance simply to spare themselves serious effort in their study of natural science. A young medical man might learn phrases instead of making laborious observations. On the other hand, one can not accuse most of the prominent *Naturphilosophen* of laziness. They were for the most part very industrious writers and thinkers and some of them did a great deal of empirical investigation. Their enthusiasm was due to their belief that they had found a general way of interpreting the results of natural science so far as these were known to them. As the age was one when, in Germany, the teaching of the natural sciences had been for some time at a low ebb in the German universities, there is something to say for the view that the whole movement of the *Naturphilosophie* was the first crude and eager beginning of a new era of scientific activity in that land, rather than a hindrance to an already developed scientific movement. For the rest, the fact that results of natural science, obtained for the most part outside of Germany, had suggested to that period new and attractive ideas, which seemed to promise surprising generalizations—this fact, I say, serves in some measure to excuse the enthusiasm of the *Naturphilosophen*. The discovery of galvanism, the general progress of the knowledge of electricity, the beginnings of chemistry, the various beginnings of discovery in the biological sciences—all these things constituted fascinating temptations to overhasty generalization. To these temptations the *Naturphilosophen* fell a prey. As to the precise extent to which the *Naturphilosophie* directly affected the scientific thought of Germany, mere statistics may show something. Three only of the philosophers who were especially identified with the movement are now remembered as of note in the history of philosophy. These are Schelling himself; the Norwegian Steffens, who mostly lived and wrote in Germany, and was professor in Halle and Berlin; and Oken, the one amongst the *Naturphilosophen* who had the most serious and varied training in natural science, and the most direct influence upon important scientific activities outside of philosophy. Oken instituted, for instance, the yearly gatherings of the German *Naturforscher* and *Aertzte*. In addition to these men, Ueberweg, in his "History of Philosophy," finds it worth while to mention, amongst the followers and allies of Schelling, ten different men who may be said to have been in the main *Naturphilosophen*. None of these are of great historical importance from the point of view of later thought, although they are men of decidedly various degrees of power and service in their time. Some philosophers of the first rank, such as Hegel, who also belong to that age, and contributed to some form of the *Naturphilosophie*, are nevertheless not to be reckoned among the *Naturphilosophen* proper, because their main work and influence lay elsewhere. Hegel's *Naturphilosophie* was only a small part of that thinker's encyclopedic system, and that part of his system contributed little to his historical influence.

If one turns to the directer influence of the *Naturphilosophie* upon the more special sciences, I find that Siegmund Günther in his "Geschichte der anorganischen Naturwissenschaften im 19ten Jahrhundert," mentions only five or six names as those of men sufficiently important on the side of

their relations to natural science to need consideration from his point of view as representatives of the *Naturphilosophie.* On the other hand, F. C. Müller, in his "Geschichte d. organischen Wissenschaften im 19ten Jahrhundert," beginning his mention of the *Naturphilosophen* who influenced the organic sciences with Schelling and Oken, adds thereupon the names of fifteen others whom he classes as "*Bedeutendste medicinische Naturphilosophen.*" Of these Steffens and Marcus have already been mentioned. The rest are described as men of various caliber—some of them medical authors, most of them professors—some of them contributors of important special researches in medicine—others less fruitful. To the most important belong Kielmeyer, who greatly influenced some portions of the work of his contemporary Cuvier, and Ignatius Döllinger, who was a center of great importance in medical teaching at Würzburg. Hirsch, in his "History of Medicine in Germany," enumerates a still somewhat larger list of more or less pronounced *Naturphilosophen* who deserve mention from the medical point of view—altogether more than a score. Hirsch, J. C. Müller and Haeser, in his "Geschichte der Medicin," agree in giving much the same impression of the activities of these men—several of them special investigators of much industry and productivity, several of them persons who gradually worked themselves free from the formulas of their philosophy—all of them injured, in the eyes of later science, by a tendency to constructive formulas of an unjustifiable type. Where they did good work, in the general biological sciences, their work was usually, as I gather, in relation to some aspect of the study of the evolution and the comparative morphology of living forms.

It is customary to say that these *Naturphilosophen* stood altogether in the way of the new awakening of the natural sciences in Germany. But as I have already said, while philosophy no doubt did medicine mischief in those days, it is still at least partly true that these *Naturphilosophen* constituted a transition from a time of scientific stagnation to one of great activity. They must be judged, accordingly, as beginners rather than as mere mischief makers. Their most characteristic work falls before 1820. Before 1830 the school had been led, in their relations to pure philosophy, by the official success of Hegel's doctrine at Berlin, to occupy a less notable place as a subordinate part of a philosophical movement in which, for Hegel himself, religious, political, and ethical issues were more important than were those of the interpretation of nature. After Hegel's death, in 1831, the movement of the *Naturphilosophie* ere long began to lose the sort of moral support that his type of constructive idealism could give to it. For the Hegelian school became absorbed in religious and in political conflicts, split up into parties, and soon lost whatever touch it had possessed with the progress of natural science. The consequence was that after 1830, the *Naturphilosophie,* neglected by the philosophers themselves, generally denounced by the academic leaders of natural science, and little defended by its own now aging followers, rapidly lost its hold upon the public. Virchow still regarded it as a danger until 1848. After 1848 he too speaks of it as altogether dead.

II

So much for the external history of the movement. But now for some words as to its leading ideas and as to its indirect influence.

An idea may be advanced by a man who has no sufficient logical right to hold it. That idea may later become fruitful in the

minds of wiser men. The originator is then often either forgotten or condemned. But the idea is none the less potent and valuable. Now amongst the leading ideas of the *Naturphilosophie* were a number which have since proved to be of no small importance in the sciences. The first of these ideas is a vague and an ancient, but a powerful idea, which the *Naturphilosophie* simply translated into more modern terms, and so prepared, as it were, for use in the new century. This is the idea that all science must strive to be one, that special research must be governed, in the long run, by the aim to bring truth into unity, and that unity is always beneath all sorts of plurality, as the basis and the meaning thereof.

I have said that this idea is vague. It always remains vague until you discover, in some field of knowledge, in what sense it is true. Then it always appears very luminous, and you rejoice in it. I have said that this idea of the essential unity of truth is ancient. The Greeks began with it. The sages and the saints lived and died for the sake of it. The church tried to secure its recognition by means of a catholic creed. The medieval mystics revelled in it. Yet many heretics also gloried in it as their own peculiar possession, and Giordano Bruno was burned for the sake of it. The modern philosophers renewed the idea. Spinoza reared a beautiful monument of thought in its honor. The *Naturphilosophen* spent their strength in proclaiming it. And since their time modern science, in the later theory of energy, in the doctrine of evolution, in various other ways which I need not enumerate, has illustrated it with unexpected brilliancy, and with marvelous precision.

Now this idea, that the unity of the truth is deeper than is even the most baffling variety of phenomena—what does this idea mean? In what sense is it a leading idea of science as well as of religion and philosophy? To this question it is easy to answer that by the unity of truth one means nothing that one would have a right to assert of any world that is foreign to human thought. One means only that man always strives and must strive for his own rational purposes, to get his ideas into some sort of rational connection, and to view them as a system. The demand that truth shall hang together and be one whole is man's demand. His reason restlessly searches for such unity, and is discontented until the quest succeeds. This is indeed the fact. Man's reason demands that man's experience shall be viewed as a connected whole. Well—this, apart from their obscurities, is precisely what the *Naturphilosophen* taught. Since they were idealists, they did not view the world as anything foreign to the human reason. Hence they founded their interpretation of the unity of things expressly upon the needs and the interpretation of man's own rational nature. Vague as their thinking was, it did therefore express a decidedly sound consciousness of the motives that lead us to seek for unity in the world of scientific truth. Now you may rightly say that the *Naturphilosophen* had no right to prescribe to nature, as they did, just how her laws should be interpreted even before they had been adequately observed. But, on the other hand, men generally do not find until they eagerly seek. The *Naturphilosophen* set their countrymen eagerly seeking for unity in nature. They specialized the vaguer ancient idea of unity by giving it conscious relations to the newer fields of natural science. I am tolerably certain that the eager search thus begun had a very real, even if a mainly indirect, influence upon the successful prosecution of the search which so soon followed the decay of the *Naturphilosophie* itself. I

shall show you in a moment a little evidence bearing upon the subject.

The second of the leading ideas of the *Naturphilosophie* related to the special form which they conceived the unity of natural truth to take. They were very fond of speculating upon the unity of what we now call the various forms of natural energy. Light, electricity, magnetism, the vital processes, these, they were disposed to insist, were forms or stages of a single, all pervasive natural process. Now, nobody with the least sense for logical connections can for a moment confuse the modern doctrine of energy, with its exactness of quantitative definitions and relations, with the vaguely conceived teleological unity that the *Naturphilosophen* ascribed to the natural world. On the other hand, nobody who considers fairly the history of the topic can fail to see that the modern doctrine of energy had two very distinct, but marvelously related sources. One of these sources was the state of modern technological knowledge in the early part of the nineteenth century. The other source is the state of general philosophy in the same period. The modern doctrine of energy is due, I insist, to a curious and unintended alliance between the interests of the engineers and the ideas of the philosophers. I shall recur to this topic again very soon. For the rest, one may say that a conception like that of the modern doctrine of energy is not found until one learns to look for it in the right spirit. The *Naturphilosophie* had its indirect part in creating this right spirit with which later men, far better equipped than were the *Naturphilosophen* themselves, looked for the truth which took form in the doctrine of energy.

Thirdly, the *Naturphilosophie* had another leading idea which more directly concerns your own science. This was the idea of comprehending organic products by conceiving them as results or at any rate as stages, of a process which has the form of an evolution. The more modern evolutionary ideas are prefigured in all sorts of vaguer and of more concrete forms by the various *Naturphilosophen*, from Schelling onwards. Oken comes nearest of all of the group to using categories like those of a modern evolutionist. When, in the generation that was in its early prime in the thirties and the forties, various naturalists made a systematic method of appealing to a study of the embryology, of the early stages, of any natural form, as a principal means of understanding its mature structure, they were following a leading idea which was again in one sense a very ancient idea, since the Greeks already possessed cruder forms of this idea. But, on the other hand, this leading idea had assumed, by the time in question, shapes which it could not have assumed had not the *Naturphilosophen* preceded. Herein lay, in all probability, one of the most substantial of their indirect influences upon the course of later science. In the minds of the *Naturphilosophen*, this idea of conceiving organic nature as a process to be understood in evolutionary, or at least in quasi-evolutionary ways, was a direct result of their philosophical principles. They not only possessed the idea; but they applied it in ways which brought it into relations with modern science. The predominance of *Entwickelungsgeschichte* in all the later studies of German science in the nineteenth century is in all probability largely influenced by the indirect effects of the *Naturphilosophie*.

As you see, no one of the three leading ideas just mentioned can be regarded as originated by the *Naturphilosophie*. Each is, in some sense and in some degree, a very old idea. But the interest of the *Naturphilosophie* lies in the fact that just be-

cause of its enthusiastic efforts to reform and to conquer the natural science of its time, it gave to these old ideas a new turn, a new setting, a new application, a new translation. The *Naturphilosophie* supposed itself to be interpreting the world of natural science in the light of its own philosophical ideas. As a fact, it was rather interpreting certain ancient philosophical ideas in the light of the facts which it learned in the course of its rather undisciplined study of science. But by thus reshaping the old ideas into modern forms, it prepared them to become leading ideas for a later generation of serious scientific workers. For, when it thus translated them into more modern terms, it rendered them comprehensible and attractive to men of the new time. It made them seem portentous to its own generation. The *Naturphilosophie* itself was soon dead, and mouldering in the grave. These leading ideas, its soul, went marching on.

III

I have now enumerated three of the leading ideas of the *Naturphilosophie.* You will properly ask what evidence there is that leading ideas derived from such sources actually influenced any serious scientific workers of a later period.

And so I come, hereupon, to a very inadequate report of an interesting class of phenomena, whose significance the historians of the nineteenth century science seem to me to have somewhat neglected. Let me call your attention to the following biographical facts regarding a number of notable scientific men.

Johannes Müller, the physiologist, born in 1801, studied from 1819 to 1822 in Bonn. His most notable teachers in medicine were *Naturphilosophen* in tendency. Bonn was then a center of medical *Naturphilosophie.* Müller later rejected the philosophy in question—how vigorously I need not tell you. But he always remained in spirit, as I have understood from the authorities, in the better sense a distinctly philosophical physiologist. He abandoned speculation, but he did not abandon synthesis. His *Habilitationsschrift* in 1830, at Bonn, related to embryology, which also received other contributions from him. His great work on physiology is a synthetic one. He always viewed his special work in its relations to the whole medical science. His influence was in the direction of unity as well as of thoroughness. Amongst his pupils were Helmholtz, Du Bois Reymond, Schwann and Virchow—all of them men of a distinctly philosophical universality of grasp.

J. L. Schönlein, born in 1793, studied in Würzburg from 1813 to 1816. Here he was under the influence of the *Naturphilosophie.* Later he, too, as I learn from the historians of medicine, achieved his scientific independence. He is called by Haeser the founder of exact modern clinical methods in Germany; and was the center of a great school of medical workers, to which Virchow also later belonged. He was a clinical organizer rather than a productive writer; but the influence of philosophical interests upon his work appears to have been decided.

To pass to another field of scientific work, Von Baer, the embryologist, was a pupil of Döllinger in Würzburg. Döllinger was a prominent medical *Naturphilosoph.* It was he who seems to have first set both Von Baer and Von Baer's contemporary and coworker Pander to work upon embryological researches. Döllinger himself, as *Naturphilosoph,* had been led to work upon comparative anatomy. His merit as the inspirer and teacher of Von Baer is expressly recognized by Franz

Müller in the latter's just quoted "Gesch. d. org. Naturw. im 19ten Jahrh."

Nägeli, the botanist, whose philosophical predispositions were very manifest in all his work, was born in 1817, was for a time under the influence of Oken, heard Hegel in Berlin, soon turned away from the *Naturphilosophie* with a decided sense of disillusionment, contributed largely to science, but remained in spirit a philosopher to the end of his days.

More indirect, but extremely obvious, is the relation of Virchow himself to the *Naturphilosophie.* Born in 1821, and growing up as he did in the generation when the *Naturphilosophie* was generally regarded with disfavor by all the strongest scientific men, Virchow, like Helmholtz, had not first to live through and overcome an adherence to the doctrines of the *Naturphilosophen.* But he too was as full of a philosophical spirit as if he had been a speculative thinker. His essay, "Die Einheitsbestrebungen in der wissenschaftlichen Medecin," belonging to the late forties, is a defense of certain leading ideas which he never could have formulated if he had not come to consciousness under the influence of the philosophical problems of his time. His interesting conception of the relation of medicine to social science, and even to politics, his definition of his own philosophy as "Humanism," his insistence upon the search for unity of knowledge as the justification of all specialism—these are all philosophical notions which one can only understand in their relations to German thought at large. Virchow's frequent return, in his various addresses, to the portrayal of the history and the merits of the controversies of the period of the *Naturphilosophie,* show how much he was dependent for his original inspiration and his spirit upon the issues that the *Naturphilosophie* defined. In what sense does science seek for unity? How is science related to religion, to the humanities, to the social interests of mankind, to the problems of the theory of knowledge? These are problems which Virchow repeatedly faces. His vindication of the right and the duty of special research is a philosophical one. Moreover, he too, as you well know, founds his work as a pathologist upon the leading idea that the study of the *Entwickelungsgeschichte* of tissues, and, in particular, of morbid growths, must be a central task for the pathologist. Experience vindicated the value of this idea. But the history of philosophy had a good deal to do with the importance which the idea had obtained during the time of Virchow's own youthful process of development.

So far for a few examples of tendencies which were in those days quite prevalent. But now for a somewhat more general view. Nobody who takes a broader survey of the history of German scholarship in the second and third and fourth decades of the nineteenth century can fail to see how wide-spread was the influence of what may in general be called the evolutionary idea upon the whole conduct of special research. It makes no difference whether you turn to pathology or to Indo-European philology, to the work of the students of jurisprudence or to that of the comparative embryologists, whether the cell-theory or Bopp's Comparative Grammar is used as your illustration—all sorts of branches of special natural research, outside of physics and chemistry themselves, and especially in Germany, were in those days guided by the idea that the most important aspect of natural objects and processes that could be studied was their historical aspect, their growth, the history of their evolution, unless indeed, as in physics and chemistry, the phenomena presented few or no points

of attack for such a type of research. In my "Spirit of Modern Philosophy," twenty years or so since, I pointed out the meaning and the historical source of this general tendency of German science and scholarship in the period in question. While preparing that book I at one time made for myself a list of those great treatises belonging to the years between 1815 and 1835—treatises issued in Germany, each one of which may be called epoch-marking in its own branch of historical or of more or less definitely evolutionary research. It is a list of notable works, which shows a constant widening and deepening interest in the growth of institutions, civilizations, art, religion, organisms, languages—in short, of whatever lives and can grow.

Now this interest in the evolutionary aspect of things had not been characteristic of the eighteenth-century science. It did not until much later become as prominent in English or in French science as, during the decades in question, it already was in Germany. Its relation during the years after 1815 in Germany to the leading ideas—to the dreams, if you will, of the previous romantic period of the *Naturphilosophie*, is historically obvious. Its relation to the later organization of the general doctrine of evolution is just as obvious. One has, therefore, to give credit to the *Naturphilosophie* for an indirect influence upon the course of the progress of the most various sciences—an influence as salutary as the direct influence of the *Naturphilosophen* had frequently been enervating or confusing. The special worker might well say, like Virchow, "You, the *Naturphilosophie*, were my enemy, from whom I happily escaped. For you counseled dreamy speculation; while I learned to look faithfully through my microscope at the facts as they were." But the *Naturphilosophie*, had it still lived to follow its own indirect influence, might have replied: "Yes, but I dreamed of evolution, and you special workers found it. I viewed the promised land from Pisgah and died. You crossed the Jordan of hard work and entered in."

To drop metaphor, the sober facts are these—facts of some importance in the history of science, although I have no wish to give them any false importance. Some of the most notable scientific discoverers of Germany in the years between 1820 or 1830 and 1860 were men who had been in their youth, sometimes directly, sometimes indirectly, under the influence of the *Naturphilosophie.* With this influence such men had in general learned to quarrel. They consciously turned away from it to special research. But the influence after all left in them a love for the universal, for the connections of things, for reflection upon the meaning of their special researches, for synthesis. And above all, this influence left in them an intense eagerness to study the connected story of the growth of organisms—a sense for the meaning of evolution—a disposition to interpret facts in the light of the growth of organized processes. Herein lay then an instructive although indirect relation between philosophy and science.

In the inorganic sciences, where the evolutionary idea was, at least at that time, and except in geology, out of place, the indirect influence of the *Naturphilosophie* showed itself mainly in a disposition to seek for the unity that binds into one system the various forms of natural energy.

As I before pointed out, the modern theory of the conservation of energy, of the equivalence of various forms of energy, and of the conditions which determine the transformations of energy, is not the product of any one set of motives. It is in fact

a remarkable example of the union of two sets of motives. The whole experience of modern industrial art gave rise to the induction that perpetual motion is in all forms impossible, that all sorts of energy must be paid for if you mean to use them, and that the expenditure of any form of energy takes place in one direction only, or, in other words, that energy will not, so to speak, run up hill without special costs due to the process whereby it is set running up hill. These were practical inductions, forced upon the users of machines by considerations of need, economy and expense. The steam engine especially taught lessons of this sort, and led Carnot to his famous "Reflections on the Motor Power of Heat." Here lay concealed one side of the coming energy theory. In England a similar union of technological and physical research also led to the threshold of the final generalization. But an important part of the theory was due to quite another sort of man, viz., to a medical man, and one who was in spirit a good deal disposed to large syntheses of a type similar to those of the former *Naturphilosophie*. In the early forties, Mayer had his attention called, while he was physician in charge of a ship's company in the tropics, to the fact that the venous and the arterial blood of his patients were not so different from one another in color as they were in a colder climate. This single fact aroused a long series of reflections upon the process of oxidation in its relation to the production of heat in the organism, and then upon the relation of chemical and organic processes in general, and then upon the relations of both to physical processes. Before Mayer returned to Europe, he had his mind full of an universal theory of the relations of the natural energies, organic as well as inorganic. The theory had the advantage over the Schellingian type of theory that it could be brought into exact relations to experience, and so tested. But in its origin it was a theory of a philosophical type such as the older *Naturphilosophie* might have used had it been acquainted with what the science of 1840 knew.

It was the union of philosophical interests and industrial needs that thus gave birth to the modern doctrine of energy. The moral seems to be that one very good foundation for important scientific generalizations lies in bringing into close relations widely philosophical and intensely and imperiously practical human interests. I think that, as the foregoing historical examples show, medicine itself has more than once greatly profited by just such an union. The industrial and the medical arts, if too much oppressed by the mere desire to accommodate themselves to the momentary needs of individual men, tend, when left to themselves, towards a shallow and unprogressive empiricism. Philosophy, by itself, tends, when applied to the subject matter of such arts, to fruitlessly vague dreams. But the union of the industrial or the strictly practical and the philosophical spirit tends to produce men like Virchow, or doctrines like the modern doctrine of energy. Hence I myself heartily welcome the introduction of technological enterprises into modern universities; and I also believe that the useful arts are all the better off for being troubled occasionally, by the neighborhood of philosophy. Philosophy, on the one hand, and the useful arts, on the other, are too often somewhat like the pine and the palm tree of Heine's well-known lyric. They are far apart; but they sometimes long for each other. It is a pity to keep them in such isolation.

IV

But now, finally, what follows from the foregoing historical sketch for our under-

standing of the logic of scientific method? I venture still to add these few summary comments as I close.

Inductive scientific generalizations, in the logically simplest cases, depend upon what Mr. Charles Peirce has defined as the method of taking a "fair sample" of a chosen type of facts. Thus one who samples, to use Mr. Peirce's typical example, a cargo of wheat, by taking samples from various parts of the cargo, carefully selecting the samples so that they shall not tend to represent one part of the cargo only, but *any* part chosen at random, employs essentially the same inductive method which, as I gather from inquiry, Virchow used in reaching the main fundamental generalizations of his cellular pathology. Samples chosen for investigation from a great variety of growths show, both in the case of normal and in the case of morbid tissues, that in the observed samples there is sufficient evidence of the origin of each cell from a previous cell, and evidence too that the tissue is formed of generations of cells whose beginnings, both in the normal and in the morbid growths, lead back to parent cells of certain definable types. This outcome of observation, repeatedly confirmed by samples fairly chosen, that is, by samples chosen from various organisms, from various tissues, and chosen not merely to illustrate the theory, but to represent as well as may be all sorts of growths—this, I say, leads to the *probable* assertion that this kind of origin of tissues is universal, and that one is dealing with a genuine law of nature. The probability of such a generalization can be tested in a more or less exact way, as Peirce has shown, by the principles of the mathematical theory of probabilities. Inductions of this type we may call statistical inductions. They presuppose nothing at the outset as to what laws are present in the world of the facts which are to be sampled. The technique of induction here consists wholly in learning, (1) how to take fair samples of the facts in question, and (2) how to observe these facts accurately and adequately. This kind of induction seems to be especially prominent in the organic sciences. Its logical theory is reducible to the general theory of probability, since fair samples, chosen at random from a collection of objects, tend to agree in their constitution with the average constitution of the whole collection.

But now, as you well know, a great deal of scientific work consists of the forming and testing of hypotheses. In such cases the inductive process is more complex. Peirce defines it first as the process of taking a fair sample from amongst the totality of those consequences which will be true if the hypothesis to be tested is true, and secondly as the process of observing how far these chosen consequences agree with experience. If a given hypothesis, in case it is true, demands, as often happens, countless consequences, you of course can not test all of these consequences, to see if every one of them is true. But you select a fair sample from amongst these consequences, and test each of these selected consequences of the hypothesis. If they agree with experience, the hypothesis is thereby rendered in some degree probable. The technique of induction now involves at least four distinct processes: (1) The choice of a good hypothesis; (2) the computation of certain consequences, all of which must be true if the hypothesis is true; (3) the choice of a fair sample of these consequences for a test; and (4) the actual test of each of these chosen consequences. So far as you make use of this method of induction, you need what is called training in the theory of your topic, that is, training in the art of

deducing the consequences of a given hypothesis. This may involve computations of all degrees of complexity. You also need training in the art of taking a fair sample of consequences for your test; for a given hypothesis may involve numerous consequences that are already known, from previous experience, to be true. And such consequences furnish you with no crucial tests. In case of success, your hypothesis may become very highly probable. But induction never renders it altogether certain.

Classic instances of this method of induction exist in the physical sciences. In the organic sciences the process of testing hypotheses is frequent, but is less highly organized, and generally less exact than in the great cases that occur in the inorganic sciences. No theory of the consequences of any hypothesis in the organic sciences has ever yet reached the degree of precision attained by the kinetic theory of gases, or by the theory of gravitation.

So much for the two great inductive methods, as Peirce defines them. But now does successful scientific method wholly reduce to these two processes, viz., (1) sampling the constitution of classes of phenomena; and (2) sampling the theoretical consequences of hypotheses? Many students of the subject seem to think so. I think that the history of science shows us otherwise.

As a fact, I think that the progress of science largely depends upon still another factor, viz., upon the more or less provisional choice and use of what I have already called, in this paper, leading *ideas.*

A leading idea is, of course, in any given natural science, an hypothesis. But it is an hypothesis which decidedly differs from those hypotheses that you directly test by the observations and experiments of the particular research wherein you are engaged. Unlike them, it is a hypothesis that you use as a guide, or in Kant's phrase, as a regulative principle of your research, even although you do not in general intend directly to test it by your present scientific work. It is usually of too general a nature to be tested by the means at the disposal of your special investigation. Yet it does determine the direction of your labors, and may be highly momentous for you.

Such a leading idea, for instance, is the ordinary hypothesis that even in the most confused or puzzling regions of the natural world law actually reigns, and awaits the coming of the discoverer. We can not say that our science has already so fairly sampled natural phenomena as to have empirically verified this assumption, so as to give it a definite inductive probability. For as a fact, science usually pays small attention to phenomena unless there appears to be a definable prospect of reducing them to some sort of law within a reasonable time; and chaotic natural facts, if there were such, would probably be pretty stubbornly neglected by science, so far as such neglect was possible. On the other hand, the leading idea that law is to be found if you look for it long enough and carefully enough is one of the great motive powers not only of science but of civilization.

It may interest you to know that the modern study of the so-called axioms of geometry, as pursued by the mathematicians themselves, has shown that such principles as the ordinary postulate about the properties of parallel lines (as Euclid defines that postulate) are simply leading ideas. What the text-books of geometry usually assert to be true about the fundamental properties of parallel lines is a principle that is neither self-evident, nor necessarily true, nor even an inductively assured truth of experience. It turns out,

in the light of modern logical mathematical analysis, to be, I say, simply a leading idea, —that is, a principle which we can neither confirm nor refute by any experience now within our range, but which we use and need in geometry precisely because it is so serviceable in simplifying the geometry of the plane.

If I may venture to cite an example from your own science, I should suggest the following: That fundamental principle of Virchow's "Cellular Pathology" which asserted the origin of every cell from a cell was, as I already said, a perfectly straightforward induction, of Peirce's first type, that is, it was a probable assertion of a certain constitution as holding for a whole type of cases—an assertion made simply because this constitution had been observed to hold for a sufficient number of fairly selected samples of the type. But, on the other hand, consider another principle which Virchow asserted already in 1847 or earlier, and which, as I have long been told, has been of the first importance for the whole later development of your science: "We have learned to recognize," says Virchow, "that diseases are not autonomous organisms, that they are no entities that have entered into the body, that they are no parasites which take root in the body, but that they merely show us the course of the vital processes under altered conditions" (*"das sie nur den Ablauf der Lebenserscheinungen unter veränderten Bedingungen darstellen"*).

Now of course I have nothing to suggest regarding the objective truth of this assertion. But I venture to point out that, logically regarded, it is not an hypothesis to be definitely tested by any observation, but is rather an hypothesis of the type of Euclid's postulate about the parallel lines, that is, it is a leading idea. For, on the one hand, how could Virchow regard this principle as one that had been definitely tested, and already confirmed by direct observation and experience at a time when, as in 1847, he was not yet possessed even of his own general principle of a cellular pathology, and when he regarded the whole science of pathology as in its infancy, and the causation of disease as very largely unknown. On the other hand, what experience could one look for that would definitely refute the principle if it were false? Would the experience of such facts as those of your modern bacteriology refute that principle? No, at least so far as I understand the sense of the principle as Virchow stated it in 1847. For when bacteria, or when any of their products or accompaniments came to be recognized either as causing disease, or as affecting the course of disease in any way, it was still open to Virchow to say that the causes thus defined simply constitute these very *veränderte Bedingungen* under which the *Ablauf der Lebenserscheinungen* takes place. In other words, the principle, if understood with sufficient generality, simply asserts that a disease can not occur in an organism without the processes of the disease being themselves alterations of the processes of the organism, and such alterations as the altered conditions, whatever they are, determine. Such a principle, so understood, seems tolerably safe from empirical refutation. It would remain unrefuted, and empirically irrefutable, so far as I can see, even if the devil caused disease. For the devil would then simply be one of the *veränderte Bedingungen*. Thus when the devils on a famous occasion entered, in the tale, into the Gaderene swine, the *Ablauf* of the *Lebenserscheinungen* of the swine was such, under the *veränderte Bedingungen*, that, as we are told, they ran down a steep place into the sea. But I do not see that this just stated pathological postulate of Virchow's need have suffered ship-

wreck, or need even have received any damage, even on this occasion. The devils are indeed represented in the tale as entities that from without entered into the swine, as bullets might have done. But the running down into the sea is *nur der Ablauf der Lebenserscheinungen* of the swine themselves. Let bullets or bacteria, poisons or compressed air, be the *Bedingungen,* the postulate that Virchow states will remain irrefutable, if only it be interpreted to meet the case. For the principle merely says that whatever entity it may be, fire or air or bullet or poison or devil, that affects the organism, the disease is not that entity, but is the changed process of the organism. What then is this hypothesis, this rejection of every external-entity-theory of disease, as the hypothesis appears when Virchow writes these words in 1847? I reply, this is no hypothesis in the stricter sense; that is, it is no trial proposition to be submitted to precise empirical tests. It is, on the contrary, a very precious leading idea. It is equivalent to a resolution to search for the concrete connection between the processes of any disease and the normal process of the organism, so as to find the true unity of the pathological and the normal process through such a search. Without some such leading idea, the cellular pathology itself could never have resulted; because the facts in question would never have been observed. And I suppose that some equivalent leading idea, if not precisely that which Virchow stated in 1847, is just as precious to you to-day in your own pathological work.

The value of such leading ideas for a science lies in the sorts of research that they lead men to undertake, and also in the sorts of work that they discourage. They are, I repeat, regulative principles. Observation does not, at least for the time, either confirm or refute them. But, on the other hand, they awaken interest in vast ranges of observation and experiment, and sustain the patience and enthusiasm of workers through long and baffling investigations. They organize science, keep it in touch with the spirit of the age, keep alive in it the sense of the universal, and assure its service to humanity. Specialism, without leading ideas, remains but a sounding brass and a tinkling cymbal.

The sources of useful leading ideas seem to me to be various. Social, and in particular industrial interests, suggest some of them, as the perennial need of paying the coal-bills for the steam engines suggested, as we have seen, one of the leading ideas which pointed the way towards the modern theory of energy. The comparison of the results of various sciences awakens such leading ideas in various minds. Schleiden set Schwamm searching for the basis of the cell theory in animal tissues. That was the suggestion of an hypothesis in the narrower sense, to be tested. But when the physical sciences set the students of organic science to the work of conceiving organic processes as mechanical in their inmost nature, that was the suggestion of a leading idea.

But another source of such leading ideas has been, upon occasion, philosophy. Philosophy itself might be defined as a systematic scrutiny of leading ideas. It has also proved to be often an inventor and interpreter of such ideas. Its faults in its work have been frequent and obvious. In answer to Dr. Councilman's request I have tried, dispassionately, to point out such faults in the *Naturphilosophie.* It has also been my duty to point out some of the excellencies that went with these defects. The moral of my story is, I suppose, that it is the interaction of various types of human thought and investigation, and not mutual isolation or contempt, which helps us all, while he

does best who works as you do in medicine with the profoundest theoretical problems and the most intensely practical interests at once pressing upon him, with the widest and most philosophical breadth of view, and the most faithful special labor, at once demanding attention.

JOSIAH ROYCE

HARVARD UNIVERSITY

SOME TABLES OF STUDENT HOURS OF INSTRUCTION

In the days of President Dunster, the publications of Harvard University gave the curriculum leading to the first degree in arts in a single sentence thus: "The first year shall teach Rhetoric, second and third years Dialectics, and the fourth year shall add Philosophy." In no such simple form are the requirements for graduation set forth in a modern college catalogue. To determine exactly what studies must and what studies may be included in the college course calls in most cases for much study. To learn even approximately how many undergraduates, or what proportion of the undergraduates, are taking courses in any particular subject is in general impossible from the college catalogue. In some departments, many courses are offered, while few students elect; in other departments, few courses are offered and many students take them. At a few institutions the enrollment figures for all classes are now available in the published reports of the president or other officer, but in most cases one must call on the recording office to obtain such figures.

For the sake of the interest which the comparison of such statistics from many institutions may afford, the following tables have been prepared. They give the registration in the various subjects at eighteen more or less representative American colleges and universities. In the first table the numbers of "student hours of instruction" are given by subjects, while the second table gives the same facts in a form more suitable for comparison of the work of different institutions, since in it all the figures have been reduced to, and are expressed in, percentages. These statistics rest on a semester basis and include in general only undergraduates—candidates for the first degree; accordingly, special students and partial course students and all graduate students, so far as possible, have been omitted. Furthermore, in the cases of the universities, only the college of arts, or the college of letters and science, according as that school of the university is named, has ordinarily been included. Thus, the Columbia statistics refer only to Columbia College, the Yale statistics to Yale College, the Harvard statistics to Harvard College, the Wisconsin statistics to the college of letters and science, etc. It is only fair to state at once, however, that the great diversity in the grouping of the work of the universities in different schools makes the results here given unsatisfactory for comparison in the cases of the universities. One university appears to include all of its undergraduate work in engineering in the college of letters, while a second university includes only a little in that school, and a third none. Other differences of similar sort have been found in comparing the figures from the universities. No such difficulties arise with regard to the statistics of the colleges and it is believed that the tables are entitled to full credence for purposes of comparison so far as all the fourteen or fifteen smaller institutions included are concerned.

The figures have been submitted in most cases by the registrar for the purpose of this paper, but in a few instances they have been compiled from the printed report of the president, dean or registrar.

A "student hour of instruction," as that term is used here, means the taking of a course of one hour per week by one student through one semester. Thus, a class of twenty students taking a three-hours-per-week course in English for two semesters gives 120 student hours of instruction in English. The number of student hours of instruction in any course for any semester is obtained by multiplying the number of students in the course by the number of hours per week which that course counts towards graduation; ordinarily, in a

non-laboratory course, the latter factor is the same as the number of class-room hours per week given to the course; while in laboratory courses, and occasionally in non-laboratory courses, this factor is less than the number of hours given to the class-room exercises of the week. It is believed that this factor has always been used, in the work of these tables, in accordance with the established ruling of the institution concerned.

The subjects have been grouped in three divisions along the lines most generally accepted, if any association of subjects has gained sufficient adoption to entitle it to a claim of general acceptance. The first division includes the foreign languages, together with archeology, philology, comparative literature and "Greek art, etc." The third division includes mathematics and the sciences. The second division includes all other subjects, particularly English, history, philosophy and allied departments. It was found unfeasible to retain in all cases the departmental or subject names used by the various institutions. Consequently, such grouping of departmental titles as seemed feasible has been made. Thus philology is made to include "classical philology" and "comparative philology"; archeology includes "archeology and art"; Romance languages includes "French," "Italian" and "Spanish"; English includes "English composition," "English language" and "English literature"; public speaking includes "oratory" and "elocution"; government includes "modern government," or "politics" and "political science,"—which seems to be used at one institution as including government only and at another as including both economics and government; economics includes "sociology," "economics and sociology," "political economy" and "commercial organization"; philosophy includes "psychology"; Bible includes "Biblical history," "Biblical literature" and "Biblical history and literature"; art includes "the fine arts," "art and archeology" and "graphic art"; drawing includes the work in that subject which seems to be properly supplementary to the department of art, while "mechanical drawing" is included ordinarily under surveying and drawing or mathematics; music includes "musical history"; mathematics includes "applied mathematics" in the case of Leland Stanford Junior University; engineering includes "graphics," "graphics and engineering," "civil engineering," "electrical engineering" and "mechanical engineering"; chemistry includes "chemistry and mineralogy"; zoology includes "entomology and bionomics"; geology includes "geology and mining," "geology and mineralogy," "mineralogy" and "mineralogy and petrography"; physiology and hygiene includes "physiology," "hygiene" and "physiology and histology"; and physical education includes "physical training" and "physical training and personal hygiene,"—the gymnasium-work component of which subject is included in the figures reported from a few institutions, but is omitted by most of them. It is acknowledged that these groupings might be changed on fuller knowledge of the facts of the particular institutions, but the various combinations mentioned may perhaps be regarded suitable and sufficient for the present purpose.

It is to be noted that the Dartmouth figures do not take into account the courses taken by the undergraduates in the professional work of the medical, Thayer and Tuck schools. Similarly, the figures for Cornell include only such work as is taken by arts students, omitting that done by other students in other colleges in that university.

The statistics from the Johns Hopkins University refer to the year 1912–13, but are submitted for this report with the statement that it is believed they are not very unlike those of 1911–12; all the other information in the tables applies to 1911–12 only. The Smith College figures are based on only the first semester of the college year, but one reads in the report from which they are taken that they differ very little for the second semester; accordingly, the same figures are used for both semesters.

The Leland Stanford Junior totals do not include the work done in the medical depart-

TABLE I. *Student Hours of Instruction of College Undergraduates, Semester Basis* 1911–12

	Amherst	Bowdoin	Bryn Mawr	Columbia	Cornell	Dartmouth	Harvard	Johns Hopkins	Mount Holyoke	Oberlin	Princeton	Smith	Leland Stanford	Wellesley	Wesleyan	Williams	Wisconsin	Yale	Oxford Honors Choices
Div. I. Foreign Languages																			
Semitics	....	....	....	....	188	....	291	45	....	....	....	....	....	....	....	....	210	....	Literae Humaniores, 147; Modern Languages, 11; Oriental Languages, 4.
Egyptology	....	....	....	....	....	....	174	....	....	....	....	....	....	....	....	....	....	....	
Sanskrit	....	....	....	....	....	12	....	....	....	....	....	....	....	....	....	....	....	....	
Greek	423	321	151	522	424	351	612	129	331	447	1,701	202	571	288	154	675	340	1,470	
Greek Art, etc	....	....	....	....	384	....	....	....	....	....	....	....	....	....	....	....	....	....	
Latin	1,110	543	1,370	1,966	710	1,029	1,158	192	1,635	857	4,076	1,532	1,160	1,047	417	1,429	1,766	2,686	
Philology	....	....	....	....	....	....	18	23	....	....	....	....	....	12	....	....	....	....	
Archeology	....	....	96	....	....	339	99	24	84	447	....	4	....	108	....	....	....	100	
Germanic Languages	1,002	900	404	2,760	2,242	3,057	4,467	470	1,447	2,450	1,971	1,930	2,863	3,329	944	1,906	10,762	2,554	
Romance Languages	1,725	825	706	3,054	2,416	4,437	5,307	427	1,395	1,534	3,429	2,242	2,782	2,760	1,214	2,014	8,384	3,366	
Slavic Languages	....	....	....	....	....	....	267	....	....	....	....	....	....	....	....	....	....	....	
Comparative Literature	....	....	66	....	....	18	1,935	....	....	....	....	....	....	....	....	....	....	....	
Totals	4,260	2,580	2,793	8,302	6,364	9,243	14,328	1,310	4,892	5,735	11,177	5,910	7,376	7,544	2,729	6,024	21,462	10,176	162
Div. II. English, History, Etc.																			
English	2,268	1,832	2,024	7,488	4,027	4,107	7,287	930	4,845	4,990	4,839	3,018	4,917	8,456	1,968	2,282	12,722	7,114	Modern History, 197; Jurisprudence, 111; Theology, 52; English Literature, 20.
Public Speaking	345	....	216	....	495	1,422	516	....	....	348	....	683	....	696	64	....	510	....	
History	681	1,113	1,082	4,622	2,066	2,793	4,467	381	1,495	1,764	....	2,106	4,192	2,771	1,528	1,845	7,654	4,854	
History, Pol. and Econ.	....	....	....	....	....	....	....	....	....	....	8,040	....	....	....	....	....	....	....	
Government	570	....	455	1,818	4,028	864	4,161	....	....	538	....	....	....	....	....	702	2,224	....	
Economics	423	921	535	1,448	....	3,666	7,719	432	951	1,769	....	1,316	3,951	1,641	1,010	1,044	6,978	4,000	
Education	....	....	100	....	575	....	228	....	703	507	....	....	1,790	1,074	....	....	....	26	
Bibliography	....	....	....	....	44	....	....	....	....	30	....	....	....	....	....	....	....	....	
Philosophy	798	699	1,208	5,316	1,709	619	3,681	248	945	2,056	2,943	1,896	1,371	2,028	1,123	889	2,930	1,540	
Anthropology	....	....	....	102	....	....	648	....	....	....	....	....	....	....	....	....	....	884	
Religion	....	....	....	544	....	....	....	....	....	....	....	....	....	....	....	105	....	....	
Bible	513	....	297	....	....	....	....	....	1,467	1,572	27	820	....	3,284	....	....	....	82	
Social Ethics	....	....	....	....	....	....	249	....	....	....	....	....	....	....	....	....	....	....	
Art	....	....	....	....	....	....	1,266	....	879	....	558	1,036	869	878	....	....	....	....	
Drawing	....	....	....	....	....	....	....	....	....	146	....	....	....	....	....	....	....	....	
Architecture	....	....	....	....	81	....	438	....	....	....	....	....	....	....	....	....	....	....	
Landscape Architecture	....	....	....	....	....	....	24	....	....	....	....	....	....	....	....	....	....	....	
Music	215	....	....	592	194	93	903	....	437	359	....	893	....	1,218	....	....	964	....	
Art and Music	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	202	
Law	....	....	....	....	552	....	....	....	....	....	....	....	2,770	....	....	....	....	1,798	
Totals	5,813	4,565	5,917	21,930	13,771	13,564	31,587	1,991	11,722	14,079	16,407	11,768	19,860	22,046	5,693	6,867	33,982	20,500	380
Div. III. Sciences																			
Mathematics	1,452	351	216	3,644	2,021	2,788	3,090	473	1,740	1,943	5,038	1,514	4,050	4,126	705	1,921	7,316	1,566	Natural Science, 88; Mathematics, 25.
Surveying and Drawing	....	66	....	....	....	....	....	54	....	....	....	....	....	....	....	....	....	....	
Engineering	....	....	....	....	915	912	2,694	....	....	....	3,379	....	5,725	....	....	....	....	....	
History of Science	....	....	....	....	....	....	120	....	....	....	....	....	....	....	....	....	....	....	
Astronomy	81	....	....	546	....	144	552	....	415	42	456	141	....	378	....	186	98	....	
Physics	345	174	501	1,192	1,688	2,457	1,473	375	541	321	3,243	405	1,096	540	387	605	4,388	1,990	
Chemistry	774	516	205	2,736	4,090	1,804	3,648	372	1,122	1,674	2,209	685	2,644	753	1,016	1,071	8,930	1,730	
Biology	1,038	222	607	....	....	....	....	216	....	....	693	....	....	....	1,624	526	3,260	1,072	
Botany	....	....	61	470	150	....	537	....	359	580	....	546	587	2,414	....	....	....	....	
Zoology	....	....	....	832	153	....	618	....	927	602	....	617	1,176	1,488	....	....	....	....	
Zoology and Botany	....	....	....	....	....	2,022	....	....	....	....	....	....	....	....	....	....	....	....	
Geology	150	117	285	600	834	315	789	183	222	456	1,356	116	2,213	816	....	174	3,550	692	
Mining and Metallurgy	....	....	....	....	....	....	435	....	....	....	....	....	....	....	....	....	....	....	
Physiology and Hygiene	....	114	35	120	....	105	1,110	....	255	555	....	....	1,180	890	....	66	768	....	
Physical Education	311	....	....	1,850	....	....	....	....	....	706	....	....	1,103	....	....	....	....	....	
Medicine	....	....	....	....	532	....	....	....	....	....	....	....	....	....	....	....	....	....	
Veterinary	....	....	....	....	18	....	....	....	....	....	....	....	....	....	....	....	....	....	
Agriculture	....	....	....	....	1,042	....	....	....	....	....	....	....	....	....	....	....	....	....	
Totals	4,151	1,560	1,910	11,990	11,443	10,547	15,066	1,673	5,581	6,879	16,374	4,024	19,774	11,405	3,732	4,549	28,310	7,050	113
Grand Totals	14,224	8,705	10,620	42,222	31,578	33,354	60,981	4,974	22,195	26,693	43,958	21,702	47,010	40,995	12,154	17,440	83,754	37,726	655

TABLE II. *Student Hours of Instruction of College Undergraduates Reduced to Percentages* 1911–12

Subject	Amherst	Bowdoin	Bryn Mawr	Columbia	Cornell	Dartmouth	Harvard	Johns Hopkins	Mount Holyoke	Oberlin	Princeton	Smith	Leland Stanford	Wellesley	Wesleyan	Williams	Wisconsin	Yale	Oxford Honors Choices	Average Percentages by Institutions, Oxford omitted
Div. I. Foreign Languages																				
Semitics					.59		.49	.91									.25		Literae Humaniores, 22.44; Modern Languages, 1.68; Oriental Languages, .61.	
Egyptology							.29													
Sanskrit						.04														
Greek	2.98	3.58	1.42	1.24	1.34	1.05	1.00	2.59	1.49	1.68	3.89	.93	1.21	.70	1.26	3.88	.41	3.91		
Greek Art, etc.					1.22															
Latin	7.80	6.23	12.89	4.66	2.25	3.08	1.89	3.86	7.38	3.21	9.26	7.06	2.47	2.55	3.43	8.20	2.11	7.14		
Philology							.03	.46						.03						
Archeology			.91			1.02	.16	.48	.38	1.68		.02		.26				.27		
Germanic Languages	7.04	10.35	3.80	6.54	7.10	9.18	7.33	9.45	6.53	9.18	4.49	8.89	6.09	8.12	7.77	10.92	12.85	6.78		
Romance Languages	12.10	9.48	6.65	7.24	7.66	13.28	8.70	8.58	6.28	5.75	7.81	10.34	5.92	6.73	9.99	11.54	10.02	8.84		
Slavic Languages							.44													
Comparative Literature			.62			.05	3.17													
Totals	29.92	29.64	26.29	19.68	20.16	27.70	23.50	26.33	22.06	21.50	25.45	27.24	15.69	18.39	22.45	34.54	25.64	26.94	24.73	24.50
Div. II. English, History, Etc.																				
English	15.94	21.05	19.06	17.74	12.75	12.33	11.95	18.70	21.84	18.69	11.01	13.91	10.46	20.63	16.20	13.08	15.20	18.87	Modern History, 30.08; Jurisprudence, 16.95; Theology, 7.94; English Literature, 3.05.	
Public Speaking	2.43		2.04		1.57	4.27	.85			1.31		3.15		1.70	.53		.61			
History	4.79	12.78	10.18	10.95	6.54	8.39	7.32	7.66	6.74	6.61		9.71	8.92	6.76	12.58	10.58	9.13	12.88		
History, Pol. and Econ.											18.25									
Government	4.01		4.28	4.31	12.75	2.59	6.82			2.02						4.02	2.65			
Economics	2.98	10.58	5.04	3.43		10.98	12.65	8.68	4.28	6.63		6.07	8.40	4.00	8.31	5.99	8.33	10.61		
Education			.94		1.82		.38		3.16	1.90			3.81	2.62				.07		
Bibliography					.14					.11										
Philosophy	5.61	8.04	11.37	12.59	5.41	1.85	6.03	4.99	4.26	7.70	6.70	8.74	2.92	4.95	9.24	5.10	3.49	4.08		
Anthropology				.24			1.06											2.35		
Religion				1.29												.60				
Bible	3.61		2.80						6.62	5.88	.06	3.78		8.01				.21		
Social Ethics							.41													
Art							2.09		3.96		1.27	4.77	1.85	2.14						
Drawing										.55										
Architecture					.25		.72													
Landscape Architecture							.04													
Music	1.51			1.39	.61	.28	1.45		1.97	1.34		4.10		2.97			1.15			
Art and Music																		.54		
Law					1.75								5.89					4.77		
Totals	40.88	52.45	55.71	51.94	43.59	40.69	51.77	40.03	52.83	52.74	37.29	54.23	42.25	53.78	46.86	39.37	40.56	54.38	58.02	46.78
Div. III. Sciences																				
Mathematics	10.21	4.03	2.04	8.63	6.41	8.36	5.06	9.51	7.85	7.28	11.46	6.98	8.62	10.07	5.81	11.01	8.73	4.15	Natural Science, 13.43; Mathematics, 3.82.	
Surveying and Drawing		.76						1.09												
Engineering					2.90	2.74	4.42				7.69		12.18							
History of Science							.20													
Astronomy	.57			1.29		.43	.91		1.87	.16	1.04	.65		.92		1.07	.11			
Physics	2.43	2.00	4.72	2.82	5.34	7.35	2.41	7.54	2.44	1.20	7.39	1.85	2.33	1.32	3.19	3.47	5.25	5.27		
Chemistry	5.44	5.93	1.93	6.48	12.95	5.41	5.98	7.48	5.05	6.27	5.01	3.16	5.62	1.84	8.33	6.14	10.67	4.59		
Biology	7.30	2.55	5.71					4.34			1.58				13.36	3.02	3.89	2.84		
Botany			.58	1.11	.45		.88		1.62	2.17		2.52	1.25	5.89						
Zoology				1.97	.45		1.01		4.14	2.25		2.84	2.50	3.63						
Zoology and Botany						6.05														
Geology	1.06	1.34	2.69	1.42	2.64	.95	1.33	3.68	1.00	1.71	3.09	.53	4.71	1.99		1.00	4.24	1.83		
Mining and Metallurgy							.72													
Physiology and Hygiene		1.30	.33	.28		.32	1.81		1.14	2.08			2.51	2.17		.38	.91			
Physical Education	2.19			4.38						2.64			2.34							
Medicine					1.68															
Veterinary					.06															
Agriculture					3.31															
Totals	29.20	17.91	18.00	28.38	36.25	31.61	24.73	33.64	25.11	25.76	37.26	18.53	42.06	27.83	30.69	26.09	33.80	18.68	17.25	28.72
Grand Totals	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

ment; and they contain results for both undergraduate and graduate students—contrary to the plan of using the figures for undergraduates only.

The statistics from the University of Wisconsin should be viewed in the light of the following statements from Dean Birge: "The college of letters and science teaches all the language, science and mathematics for the colleges of engineering and agriculture. This gives us a great many students in the elementary classes who take their advanced work in other colleges. This fact would make the advanced work relatively smaller than it would be if the college of letters and science alone were concerned. It increases the registration in modern languages, English, chemistry, physics and mathematics very considerably." The figures for the first semester are used, with permission, for both semesters in the case of Wisconsin.

The numbers of those who entered for the different final honors schools in 1912 at the University of Oxford have been included in the tables. Perhaps much more value would attach to statistics which should include the "pass" men also; but figures showing the lines along which the choices of the more earnest students at this great English university fall are regarded of at least sufficient interest to warrant their inclusion here.

In the order of the relative amount of work done in the foreign languages, the seventeen American institutions considered rank, according to this table, for the year in question thus: (1) Williams, (2) Amherst, (3) Bowdoin, (4) Dartmouth, (5) Smith, (6) Yale, (7) Johns Hopkins, (8) Bryn Mawr, (9) Wisconsin, (10) Princeton, (11) Harvard, (12) Wesleyan, (13) Mount Holyoke, (14) Oberlin, (15) Cornell, (16) Columbia, (17) Wellesley and (18) Leland Stanford Junior, with the Oxford honors men standing between Princeton and Harvard.

Similarly, the order as to the amount of work done in the subjects of the second division (English, history, philosophy, etc.) is as follows: (1) Bryn Mawr, (2) Yale, (3) Smith, (4) Wellesley, (5) Mount Holyoke, (6) Oberlin, (7) Bowdoin, (8) Columbia, (9) Harvard, and, with a long interval, (10) Wesleyan, (11) Cornell, (12) Leland Stanford Junior, (13) Amherst, (14) Dartmouth, (15) Wisconsin, (16) Johns Hopkins, (17) Williams and (18) Princeton, with the Oxford honors men preceding Bryn Mawr.

Again, the order for the division of science stands thus: (1) Leland Stanford Junior, (2) Princeton, (3) Cornell, (4) Wisconsin, (5) Johns Hopkins, (6) Dartmouth, (7) Wesleyan, (8) Amherst, (9) Columbia, (10) Wellesley, (11) Williams, (12) Oberlin, (13) Mount Holyoke, (14) Harvard, (15) Yale, (16) Smith, (17) Bryn Mawr, (18) Bowdoin, with the Oxford honors men last of all.

In general, the eastern institutions show a greater amount of work in the foreign languages than the western, while the western show much larger numbers in science. In the second division the line between the east and the west is not nearly so clear, while Yale and the colleges for women stand together at the head of the list. Amherst and Dartmouth stand much closer to each other in the distribution of their work along these three lines than do any other two of the group which includes them and Bowdoin, Wesleyan and Williams. Johns Hopkins and Wisconsin present results which are very similar; and so do Smith College and Yale College, while Bryn Mawr stands very close to both.

One hesitates to try to account for these differences of distribution of work in our colleges. Probably the presence or absence of required courses, the economic and social factors of the time and place, the influence of women in coeducational institutions, the countless personal equations and all those tendencies, accidental, traditional and historical, which enter in the making of a curriculum and the creation of the student sentiment towards it—all these and many more must be the reasons which together determine these things. Into these questions the statistician makes no attempt to enter. The tables are presented simply as shedding a bit

of light of some interest on the great subject of American collegiate education.

FREDERICK C. FERRY

SCIENTIFIC NOTES AND NEWS

THE statue of Lord Kelvin, erected in Kelvin Grove Park, Glasgow, was unveiled on October 8. Mr. Augustine Birrell, rector of Glasgow University, made the address, and at the luncheon which followed an address was made by Mr. Arthur Balfour. The statue, which is of bronze, is the work of A. McF. Shannan.

COLONEL GEO. W. GOETHALS, chairman of the Isthmian Canal Commission and chief engineer of the Panama Canal, has accepted the honorary presidency of the International Engineering Congress and will preside over the general session to be held in San Francisco, September 20-25, 1915.

PROFESSOR THEOBALD SMITH, of Harvard University, has accepted membership on an International Committee with Professor Gaffky, of Berlin, and Professor Calmette, of Lille, to award in 1914 the first Emil Chr. Hansen Prize for researches in medical microbiology.

THE Warren triennial prize for 1913, amounting to $500, has been awarded to Dr. Arrigo Visentini, instructor in pathologic anatomy in the Royal University, Pavia, Italy, for his essay entitled, "Function of the Pancreas and its Relation to the Pathogenesis of Diabetes."

AT its last meeting the Rumford Committee of the American Academy made the following appropriations: To Professor W. O. Sawtelle, of Haverford College, $300, in addition to a former appropriation, in aid of his research on "The spectra of light from the spark of an oscillatory discharge"; to Professor G. N. Lewis, of the University of California, $300, in addition to a former appropriation, in aid of his researches on the "Free energy changes in chemical reactions"; to Professor H. N. Davis, of Harvard University, $200, in aid of his various thermodynamical researches.

DR. CARL VOEGTLIN, associate professor of pharmacology in the Johns Hopkins University, has been appointed professor of pharmacology in the hygienic laboratory, U. S. Public Health Service, to succeed Professor Reid Hunt, now head of the department of pharmacology at Harvard University.

PRIVATDOZENT DR. CARL TIGERSTEDT, of the physiological institute of the University of Helsingfors, Finland, recently appointed as research associate of the Carnegie Institution of Washington, is spending the winter in the Nutrition Laboratory in Boston.

ALBERT W. WHITNEY has resigned his position of associate professor of insurance and mathematices in the University of California to become assistant actuary in the Insurance Department of the State of New York.

PROFESSOR GAFFKY, director of the Institute for Infectious Diseases, Berlin, retired from his position on October 1. His successor will probably be Professor Loeffler, of Greifswald.

PROFESSOR A. OBRECHT has been appointed director of the Santiago Observatory in succession to the late Dr. Ristenpart.

DR. ROGER CROISSANT, Paris, is visiting the United States, to study the system of training nurses with a view of organizing similar work in France.

DR. JOSEF SCHUMPETER, professor of political economy in the University of Graz, Austria, has been named as the Austrian exchange professor for the winter semester of 1913–14 at Columbia University. He is a graduate of the University of Vienna in 1906, and studied later in Berlin and England, in which latter country he remained until 1908. Dr. Schumpeter writes and speaks the English language perfectly.

DR. RHODA ERDMANN, of the department of protozoology of the Berlin Institute for Infectious Diseases, has been appointed Seesel research fellow in zoology at Yale University, to enable her to study Professor Woodruff's pedigreed race of *Paramæcium*.

DR. BURT G. WILDER, emeritus professor of neurology and vertebrate zoology in Cornell University, will reside hereafter in Brookline, Mass., the home of his boyhood. His address

this winter is 60 Park St. For the present he has given up scientific research in order to complete his "Records and Recollections of the Civil War," based upon his daily letters, which were all preserved.

Professor W. M. Davis, of Harvard University, lectured on "The Lessons of the Colorado Canyon," at Denison University, October 6; at Ohio Wesleyan University, October 7; at Ohio State University, October 8; at State Normal College, Ypsilanti, October 10, and at the University of Rochester, October 13. He also spoke on "Glacial Erosion in Montana" at Ohio Wesleyan; on "The Bearing of Physiography on the Theories of Coral Reefs," at Columbus, and on "Experiences of an Exchange Professor at Berlin and Paris," at Ypsilanti.

"The Physical Basis and Determination of Sex" was the subject of an illustrated address given on October 18 by Associate Professor H. H. Newman, of the department of zoology of the University of Chicago, at Fullerton Hall, Art Institute of Chicago, under the auspices of the Field Museum of Natural History.

Dr. Hideyo Noguchi gave a demonstration at a meeting of the Royal Society of Medicine, London, on October 13, of the results of his recent investigations, most of them carried out at the Rockefeller Institute of Medical Research, of which he is an associate. He showed pure cultures of various pathogenic and saprophytic spirochetes, demonstrated the presence of *Treponema pallidum* in the brain in cases of general paralysis, and showed experimental general paralysis in rabbits. He also gave a demonstration of his recent cultural studies of the virus of rabies.

Mr. Clayton D. Mell, of the U. S. Forest Service, sailed on October 16 from New York for British Guiana to inspect greenheart timber to be used in the construction of docks and other marine works for the Panama Canal.

Mr. R. A. Rowley, assistant professor of geology in the University of the Philippines, has recently returned from an expedition to the northern part of the Island of Palawan, and is engaged in working up a suite of rocks from that little known region.

It is stated in *Nature* that Major Barrett-Hamilton, accompanied by Mr. Stammwitz, one of the taxidermists on the staff of the British Museum (Nat. His.), has sailed in a whaler for South Georgia, on a mission from the Colonial Office, to report on the whaling stations leased by the British government to a Norwegian firm.

A branch laboratory of the United States Bureau of Mines has been established in Morse Hall, Cornell University, in connection with the department of chemistry. Investigations will be made of problems related to the manufacture of brass and other alloys of copper by Dr. H. W. Gillett and Dr. J. M. Lohr under the direction of Dr. Charles Lathrop Parsons, chief mineral chemist of the Bureau of Mines, and Professor Bancroft.

The sixty-seventh anniversary of Ether Day was celebrated at the Massachusetts General Hospital, Boston, on October 16, when the principal address was delivered by Dr. Milton J. Rosenau.

We learn from *Nature* that at the recent International Congress of Pharmacy held at the Hague, a proposal to form an international pharmacopœial bureau was discussed, and a commission was appointed to consider the question, and to submit to the International Pharmaceutical Federation at an early date a scheme for the establishment of such a bureau. The commission is composed of seven members, representing, respectively, Great Britain, the United States, Germany, France, Holland, Belgium and Switzerland; most of the members are associated with the revision of their national pharmacopœias, the English representative being Professor H. G. Greenish, joint editor of the "British Pharmacopœia," and the American, Professor J. P. Remington, editor of the "United States Pharmacopœia." Among the duties of such a bureau as that proposed would be the collection and examination of all literature relating to pharmacopœial revision and the experimental investigation of new drugs and preparations, and no doubt the

influence of the bureau would tend to encourage the work already commenced in the direction of the unification of pharmacopœias.

AT the request and with the cooperation of the Massachusetts Society for the Prevention of Cruelty to Animals, the faculty of medicine of Harvard University offers a course of free public lectures, to be given at the Medical School, on Sunday afternoons, beginning October 5 and ending December 21, 1913. The lectures begin at four o'clock.

October 5, "The Protection of Domesticated Animals," Professor Veranus A. Moore, of Cornell University.

October 12, "Our Increased Knowledge concerning the Nature of Animal Diseases," Dr. George W. Pope, of the Bureau of Animal Industry, Washington.

October 19, "The Dangers of Live-stock Traffic," Professor Karl F. Meyer, of Philadelphia.

October 26, "Stable Ventilation" (with lantern-slide demonstration), Professor James B. Page, of Amherst.

November 2, "Modern Operative Methods applied to Veterinary Surgery," Professor Harvey Cushing, of Boston.

November 9, "The Relation between Human and Animal Tuberculosis," Professor Theobald Smith, of Boston.

November 16, "Protection of Animals from Infective Diseases," Dr. Charles H. Higgins, of Ottawa.

November 23, "The Diseases and Care of Poultry and the Pig," Dr. Austin Peters, of Boston.

November 30, "The Diseases and Care of the Dog and the Cat," Dr. Arthur W. May, of Boston.

December 7, "The Diseases and Care of the Horse and the Cow," Dr. F. H. Osgood, of Boston.

December 14, "Rabies and Glanders," Dr. Langdon Frothingham, of Boston.

December 21, "The Relationship between Human and Animal Diseases in the Tropics," Professor R. P. Strong, of Boston.

THE Vienna correspondent of the British Medical *Journal* writes that the events of the past year have forced the senate of the University of Vienna to the unwelcome conclusion that the university no longer occupies the position it once held in the esteem of foreign scientific men. This has been proved by the fact that the well-known physiological chemist, Professor Abderhalden, refused the directorship of the chemical institute left vacant by the departure of Professor Ludwig, whilst the post of director of the medical clinic, formerly held by Professor von Noorden, has likewise been declined by Professor His, of Berlin. These refusals, which were totally unexpected and caused very great surprise, are in themselves sufficient to prove that the university is to blame for this loss of prestige; whilst the resignation of two such eminent German scientific men as Professor von Strümpell and von Noorden, both men in the prime of life, seems to point to the existence of some grave cause for dissatisfaction on the part of foreign professors. It is said that the matter has provoked much comment among the medical profession in Austria, which is beginning to express its disapproval of a régime that has had the effect of driving strangers away from Vienna, instead of attracting them to it. It is evident that some reformation of the existing conditions is needed, and it rests with the profession to see that this is properly carried out. In the meantime, temporary substitutes have been appointed to vacant posts in the persons of Professor Nauthner to the chemical institute and Professor Salomon to von Noorden's clinic. Public opinion is said to be in favor of the reservation of these posts in future for Austrians but religion, race and politics play as important a part in their selection as scientific attainments.

STATISTICS of the electrical machinery, apparatus and supplies industry in the United States for 1909 are presented in detail in a bulletin soon to be issued by the Bureau of the Census. It was prepared under the supervision of W. M. Steuart, chief statistician for manufactures. This industry includes the manufacture of the machines and appliances used in the generation, transmission and utilization of electric energy, together with most of the parts, accessories and supplies for them. It does not include, however, the production of poles, whether of wood, iron or steel; nor

does it include the manufacture of glass and porcelain ware made expressly for electrical purposes, that of bare iron and copper wire, or any of the group of electrochemical and electrometallurgical products. The total number of establishments in the United States in 1909 engaged in the manufacture of electrical machinery, apparatus and supplies, was 1,009. The total number of persons engaged in the industry was 105,600, of whom 102,950 were wage earners. The total capital employed was $267,844,432, and the total value of products was $221,308,563. The industry in 1909 was largely centralized in the six states of New York, Pennsylvania, New Jersey, Massachusetts, Illinois and Ohio. These states together reported 83.9 per cent. of the total average number of wage earners, 82.6 per cent. of the total value of products and 83.1 per cent. of the total value added by manufacture.

UNIVERSITY AND EDUCATIONAL NEWS

The Graduate College of Princeton University was formally dedicated on October 22. Professor Andrew F. West, dean of the graduate school, made the principal address, his subject being "The Household of Knowledge." Addresses of congratulation were made by Dr. Alois Riehl, professor and former rector in the University of Berlin; Dr. Arthur Shipley, master of Christ's College, Cambridge; Dr. Arthur Denis Godley, fellow of Magdalen College and public orator in the University of Oxford; M. Emile Boutroux, honorary professor in the University of Paris and president of the Foundation Thiers, and by President Nicholas Murray Butler, of Columbia University. The Cleveland Memorial Tower was then presented by Mr. Richard V. Lindabury, president of the Cleveland Monument Association, and accepted on behalf of the university by President John Grier Hibben. A memorial address on "Grover Cleveland" was then made by ex-President William Howard Taft. Earlier in the week the foreign guests gave public lectures, the subject of Dr. Shipley's address being "The Origin of Life."

Dr. Christian B. Holmes has been appointed dean of the medical department of the University of Cincinnati, succeeding Dr. Paul G. Woolley.

At the University of California, Frank LeRoy Peterson has been appointed assistant professor of farm mechanics, and Dr. Max Morse, instructor in physiology.

Charles T. Kirk, Ph.D. (Wisconsin, '11), has been appointed professor of geology in the University of New Mexico.

Miss Fanny C. Gates, formerly head of the department of physics at Goucher College, has been appointed dean of women and professor of mental and physical hygiene in Grinnell College.

Mr. George R. Johnstone, A.B. (Illinois, '13), has been appointed instructor in botany at the Michigan Agricultural College, making four instructors in addition to professor and assistant professor, who give the full time to instruction in botany, with two research assistants giving a quarter of their time respectively to plant pathology and plant physiology. Five hundred and twenty-one students have registered for work in the botanical department, being an increase of twenty-five per cent. over last year.

Mr. William C. Willard, C.E., M.Sc., Lehigh University, has been appointed assistant professor of railway engineering at McGill University, Montreal.

At Birmingham University Dr. F. C. Lee has been nominated to the chair of civil engineering vacated by Professor S. M. Dixon. Professor P. F. Frankland, F.R.S., has been elected dean of the faculty of science in succession to Professor Dixon.

DISCUSSION AND CORRESPONDENCE

COMMENTS ON PROFESSOR BOLLEY'S ARTICLE ON CEREAL CROPPING

It is now rather late to refer to Professor Bolley's article on "Cereal Cropping," published in Science on August 22, but I can not refrain from calling in question his statements in regard to the deterioration in the quality of wheat grown on soils which are "exhausted"

or "sick." The question of yield I shall not touch upon further than to say that the only instances which have come under my observation where a total crop failure has occurred (and which could not easily be accounted for by weather conditions or attacks of recognized diseases, insects, etc.) have been on *new* lands.

It is certainly a common idea of millers that the quality of wheat has steadily deteriorated in most localities where it has been grown for many years; but one can not be expected to receive as conclusive a popular opinion unsupported by evidence. As Professor Bolley says, "In late years there has been a vast amount of talk about cereal crop deterioration" both in regard to quantity and quality. But "a vast amount of talk" is one thing, and scientific proof quite another.

He asks:

> Why is it that fertile wheat lands do not produce wheat of reasonably normal quality?

Further on he refers to

> the evident rapid deterioration of the quality of grain which invariably accompanies the first few years of cropping upon the new land areas. Indeed, in some of the newer great wheat-producing regions the most fertile new lands do not produce wheat now either in yield per acre or in quality similar to that which adjoining lands did when first put under wheat culture. Commonly, the new lands at first, even though of light texture, and of low chemical fertility, are expected and usually do produce grain above the ordinary average as to quality in color, form and milling texture, but, very soon, the yield per acre and the quality drops off to such extent that the millers complain bitterly.

Again he refers to the "low yield and invariable deficiency in quality." Further on occur these words:

> In spite of these directions [by our best agriculturists] the wheat soon becomes soft and shows all of the peculiar characteristics which we find named in the literature of the chemical laboratory, or in the milling tests of wheat as previously indicated, "white-bellied," "piebald," or shrivelled, bleached and blistered, "black-pointed," in fact all the qualities of deteriorated grain.

Where farm manure is applied, he says:

> There may be increased yields, with vital deterioration in quality of seed produced.

I am not sure of the exact meaning of the word *vital* in this case, but presume that it means *hereditary*.

I hope I am not one of those who are "too cocksure of their scientific principles," but I certainly disagree with Professor Bolley and venture to bring forward a little evidence for my views.

It is a fact that "piebald" or "yellowberry" wheat, which is counted of poor quality by millers because of its softness, is often produced (in Canada) on newly cleared land. Some years ago when searching for very soft (*i. e.*, low grade) wheat in Manitoba, I was obliged to go to new land, on which the first crop was being raised. There I secured an extremely poor (though plump) specimen of Red Fife wheat, so soft that an ordinary miller would almost refuse to buy it. That this is a common occurrence is proved by a large number of examples, and I venture to say that every careful student of wheat in Canada will agree with me on this point. I have never seen any wheat grown on old land, in the great spring-wheat areas of Canada, as soft as some of the samples from new lands. Without being able to quote specific proofs, I believe it is true that these new lands gradually by cultivation become altered in their texture so as to produce wheat of harder grade, *i. e.*, superior wheat from a miller's point of view. In other words the actual process is one of gradual improvement and not of degeneration. I believe that the popular idea of "degeneration" (which is prevalent in eastern Canada) is due, in so far as there is any truth in it, to the farmers growing inferior varieties, which are supposed to give larger yields than Red Fife when grown on partially exhausted soil.

That wheat is not growing poorer in quality on this farm or in the Ottawa Valley is clearly shown by the excellent samples produced this season, and indeed in most seasons since 1902, which was a soft wheat year. If there is any tendency to gradual change it seems to be in the direction of improvement. I fully expect,

however, that when a suitable season for the production of soft wheat occurs again, the crop will be quite as soft as in 1902.

A careful series of milling and baking tests of wheat from highly fertilized and exhausted soils (or soils on which wheat had been grown repeatedly) was made by me a few years ago. These results have not yet been published, but they prove, in so far as one series of tests can prove anything, that there is no essential difference in flour quality between samples of wheat raised under the two extreme conditions. I have not seen any trustworthy evidence whatever that wheat grown on poor soil (whether "exhausted" or "sick") is inferior for milling and baking purposes to that grown under more favorable conditions, except as regards plumpness, and even there I am not at all sure that the smaller crop from poor soils is as a rule distinctly less plump. I suspect that the lower yield, which is, of course, obtained, is due essentially to a smaller number of kernels rather than to imperfect development of them.

I hope that Professor Bolley will find time to give to the public some of the evidence on which his statements are based, especially the milling and baking tests, and some instances of "vital deterioration in quality of seed," due to manuring.

CHAS. E. SAUNDERS

EXPERIMENTAL FARM,
OTTAWA, CANADA,
October 8, 1913

"QUITE A FEW"

TO THE EDITOR OF SCIENCE: The criticism of T. G. Dabney, in SCIENCE of September 5, of the phrase "quite a few," used by Professor Bolley in his paper in SCIENCE of July 11, is calculated to excite a surprise among his readers equal, probably, to that which Mr. Dabney himself feels towards Professor Bolley. But "quite a few" conveyed Professor Bolley's meaning perfectly, and, for myself, I can not think of a satisfactory equivalent that could have been substituted. *Quite a number* is a phrase sufficiently commonplace, probably—if it had been used—to have escaped Mr. Dabney's eagle eye, but is no more precise. What more can an essayist ask, and what can a reasonable critic object to, if a writing is so worded—albeit slightly colloquial—that its meaning is taken instantly?

If purists are to pounce on all our colloqualisms whenever they happen to be found isuing "from a learned teacher, in a scientific disquisition in a scientific journal" and articles are to be reduced to the cast-iron requirements of such critics, then the readers thereof will lose some valuable time. For it takes time to get the meaning of a thoroughgoing pedant. What should be said, for instance, of the phrase "pretty nearly," which is *pretty* common, I believe, among good writers? "Pretty" refers to the looks of a thing. Would anybody say that "pretty nearly" must be taken to mean *nearly pretty?* Then there is "Now then," a favorite phrase of lecturers introductory to the elucidation of some point just previously dated. If it means *now,* Mr. Dabney might say, it can not mean *then.* Take the word "scientist," which is admittedly a barbarism and one that has been fought against for forty years, yet sticks in the language like a burr, because of its usefulness—what are we going to do with that? Why, use it, of course, and snap our fingers at etymology and consistency, for it takes the place of three words and can not possibly be misunderstood.

The fact is, the English language defies argument. Vagrant words, phrases and sentences, illogical and intolerable at first, are every now and then creeping into usage and refusing to be turned out. In the beginning they may excite loathing, then they are simply frowned on and avoided whenever possible—though often through considerable circumlocution—but in the end they become "good English." And the chances are that some day we are astonished to find some of them in Shakespeare—like "a bum bailiff," for example, which he who looks for will find there.

The meaning to be conveyed is the desideratum above everything else. That may be developed with much labor, in sentences always capable of parsing and always logical, or the writer may show a little more elasticity

of style and be just as well, if not better, understood. He will also be more agreeable to "quite a few" of SCIENCE's readers I have no doubt, among whom is

HENRY K. WHITE

CATONSVILLE, MARYLAND,
September 25, 1913

SCIENTIFIC BOOKS

A Biological Survey of the Waters of Woods Hole and Vicinity. Section I., Physical and Zoological, by FRANCIS B. SUMNER, RAYMOND C. OSBURN and LEON J. COLE. Section II., Botanical, by BRADLEY M. DAVIS. Section III., A Catalogue of the Marine Fauna, by FRANCIS B. SUMNER, RAYMOND C. OSBURN and LEON J. COLE. Section IV., A Catalogue of the Marine Flora, by BRADLEY M. DAVIS. Department of Commerce and Labor. Bulletin of the Bureau of Fisheries, Vol. XXXI., 1911. Washington, Government Printing Office. 1913.

This bulletin is issued in two parts, each a separate volume; Part I., 544 pages, of which 54 contain introductory explanations and physical data, the remainder giving the results of the dredging operations carried on by the bureau, supplemented by some observations on conditions in shallower water, where dredging was not necessary. In this part 274 charts and maps are included. The second part contains 316 pages, numbered continuously with the first part. It consists of catalogues of the marine animals and plants, with localities, etc., bibliographies of works referring to the region in question, and ends with what appears to be a complete index. The present notes refer to the botanical parts, which occupy 147 pages, as against 620 pages for the zoological; but some reference is necessary to the introductory part.

The region under consideration includes Vineyard Sound and Buzzards Bay; the main body of the information on which this work is based was obtained by dredgings in the years 1903, 1904 and 1905, and a few in 1907, from the government steamers, *Fish Hawk*, *Phalarope* and *Blue Wing*. In all 458 stations were dredged, of which a list is given, showing date, location, depth and character of bottom. Charts 225 to 227 also show these data graphically. At each station a record was kept of the species brought up by the dredge, so that the data as to distribution may be considered as fairly complete. The result of this, as regards 38 species of algæ, is shown on charts, identical outline charts of the region, one for each species, with a star showing each station where the species was found. No verbal description can express as clearly as do these charts the area inhabited by a species, and their value is especially shown when one compares the eight similar charts in the zoological section, showing, not distribution of species, but temperature, density, etc. Compare, for instance, chart 228, *Chætomorpha melagonium*, a northern plant, occurring here only in the colder waters by Gay Head and Cuttyhunk; chart 237, *Laminaria digitata*, also northern, about Gay Head only; chart 241, *Griffithsia Bornetiana*, almost entirely in the warmer waters near shore; chart 242, *Griffithsia tenuis*, a common plant of the Mediterranean and Bermuda, here reaching its northern limit, and here recorded only in the extreme northern portion of the chart, where shallow water and distance from the open sea give a higher temperature than in the more southern part of the bay or in the sound.[1]

With these chart 261, *Grinnellia americana*, is in strong contrast, showing an almost universal distribution for this beautiful and characteristically American species.

The dredgings on which the charts were based were all made in the months of July, August and September; that different results would have been obtained by dredgings in other months is quite possible, especially as regards annuals, but probably the difference would be less than what is found between tide marks, or just below low-water mark; at such

[1] *G. tenuis* also occurs just east of the region represented in the charts, but only in such bodies of water as Waquoit Bay, which are very shallow, connected with the sea by a narrow channel, and in which in summer the temperature of the water is quite high.

stations in practically all temperate regions a large number of species appear, often abundantly, in late winter and early spring, only to disappear before the midsummer flora is established. This deficiency in data for other than the summer months is in part compensated for by a careful study which Dr. Davis has made of a very limited region, "Spindle Rocks," continuing over a period of fifteen months, after which the rocks were removed in connection with a widening of the ship channel. The eight charts given show zones of growth about each rock, and the appearance, maximum and disappearance of the various species of algæ.

Section IV., list of the marine algæ, is intended to include all species whose occurrence in the Woods Hole region is properly vouched for, including many forms not noted in Section II. Details of distribution, exact localities for rarer forms, dredging stations, seasonal occurrence, references to publications and to exsiccatæ, with synonyms, make this section very complete. The total number of species and the proportions of the different classes are as follows:

Cyanophyceæ	37
Chlorophyceæ	48
Phæophyceæ	66
Rhodophyceæ	89
Total	240

The Woods Hole region has had prominence in the marine algology of New England since the publication of Farlow's list of 1873.[2]

In addition to the investigations of the Fish Commission and its successors, of which the work now under consideration is the latest result, the Woods Hole Marine Biological Laboratory has maintained a summer school here for over thirty years, and the records and herbarium of the laboratory have been utilized in making up this list, which may be considered as approximating completeness nearly enough to justify drawing some general conclusions. Into these conclusions Dr. Davis has gone in some detail; and as to the general character of the flora of this region, the older hypothesis seems justified, that Cape Cod is a relatively sharp boundary line between a subarctic flora, inhabiting the shores north, and a warm-water flora extending south; but with isolated colonies of northern plants in the south, of southern plants in the north.[3]

Dr. Davis's comments on the influence of tides, currents, etc., seem to be well reasoned out and conservative.

The present notes give of course a very incomplete idea of the fullness of the work, which is noteworthy also as the first American attempt to represent the distribution of algæ graphically, rather than by description; indeed the writer can not recall any European work of the same character. Rosenvinge[4] in the first part of his treatise on the algæ of Denmark has given a long list of dredgings, with data of depth, bottom, etc., but there is no indication that any graphic representation is planned. Something resembling this has occasionally been attempted in regard to flowering plants, as for instance by Fernald,[5] Stone,[6] but in these the shading or dotting indicates an area, not a station. The charts for Spindle Rocks are practically unique by their exactness

[2] W. G. Farlow, "List of the Seaweeds or Marine Algæ of the South Coast of New England," Report of U. S. Commission of Fish and Fisheries for 1871–72 (1873), pp. 281–294.

[3] The distinction of an arctic flora on one side of Cape Cod and a warmer flora on the other requires some modification if exactness is wanted. The writer's observations have shown that at Eastham and Welfleet, 25 miles north of Woods Hole, the Massachusetts Bay shore of the cape has a summer flora practically the same as that of the shore of Buzzards Bay. More observations are needed, but it is probable that the flora on both shores of the cape is much the same.

[4] L. Kolderup Rosenvinge, "The Marine Algæ of Denmark, Contributions to their Natural History," *Kgl. Dansk. Vidensk. Selsk. Skrifter*, 7 Raekke, Vol. VII., No. 1. Kobehavn, 1909.

[5] M. L. Fernald, "An Expedition to Newfoundland and Labrador," *Rhodora*, Vol. XIII., p. 109, 1911.

[6] Witmer Stone, "The Plants of Southern New Jersey," Annual Report of the New Jersey State Museum, 1910 (1911).

and their completeness through the year. Considerable attention is given to the matter of "formations" and "associations," as is the custom nowadays in works treating of distribution; it may be a question how far subdivision should be carried in this matter, and whether it is wise to refer to the "*Nemalion* association," "*Dasya* association" and the like, to indicate that a single species grows plentifully in certain localities, without, as far as stated by the author, admixture of any other plant. While much attention is paid to the habitats of the different species, favorable and unfavorable conditions, epiphytes, etc., the word "ecology" is generally conspicuous by its absence; this is to the writer a good sign, as authors who most enjoy using it seem often to be persons with a distaste or contempt for systematic botany, and the systematic botanist has learned to be somewhat cautious in accepting the names used for the plants making up their "associations," etc. The case is stated very compactly in a footnote to a recent paper by Tidestrom.[7]

While there will always be differences of opinion as to the limitations of species, etc., the writer, who is fairly familiar with the New England marine flora, has not found anything to indicate an error in determination in Dr. Davis's list.

While this work is by far the most complete study of the marine flora of any limited region of this continent, it leaves plenty of questions for further study. Among them the writer would suggest as specially interesting the matter of the different range in latitude on the two sides of the Atlantic, of a species occurring on both sides. The occurrence in the Woods Hole region of many Mediterranean species, but the absence of others associated with them in Europe, was long ago pointed out. While this is not taken up by Dr. Davis, it would seem to the writer that it may be due to the much greater range of temperature at Woods Hole, as indicated by the charts, etc.; a Mediterranean annual demanding a high summer temperature, but passing the winter in the spore state, would find no difficulty in living here; while it would be impossible to acclimate an alga requiring a temperature of at least 40° Fahr. throughout the year. But some other cause must be found in the case of a species like *Hypnea musciformis,* abundant and luxuriant at Woods Hole, but not reaching to the English Channel; while *Dictyota dichotoma,* at its best on the English coast, has not been found with us north of North Carolina.

Botanists who desire uniformity of nomenclature will be glad to see that the international rules, as adopted at the Vienna Congress of 1905, are here followed,[8] and it is a matter for congratulation that so careful and thorough a work as Dr. Davis's has been brought out in so good shape as a government publication.

Frank S. Collins

North Eastham, Mass.

[7] "Much argument ecological falls of its own weight when the entities considered are not known to the observers." Ivar Tidestrom, "Notes on Vol. XV., p. 104, 1913.

[8] The results of the Brussels Congress of 1910 were not published at the time Dr. Davis's manuscript was accepted by the government; under the rule that the names of Nostocaceæ heterocysteæ and Nostocaceæ homocysteæ date, respectively, from the "Revision" of Bornet & Flahault, and the "Monographie" of Gomont, a few names of authors, given in parenthesis by Dr. Davis, would be omitted, but no generic or specific names would be changed. It is possible that under a strict construction of the Vienna rules the name of *Griffithsia Bornetiana* may have to be given up; but as the few writers who have proposed a substitute use a name certainly unjustified by the same rules, Dr. Davis has done well to retain, in company with all other American algologists, the specific name given by Farlow.

A Bibliography of the Tunicata, 1469–1910. By John Hopkins, F.L.S., F.G.S., F.Z.S., etc., Secretary of the Ray Society. Printed for the Ray Society and sold by Dulau & Co., Ltd., 37 Soho Square, London, West, dated 1913.

The author prepared a portion of this bibliography, dealing with titles up to the year 1870, in connection with his preparation for

publication of Alder & Hancock's "British Tunicata." He has since completed it through the year 1910. He has added many titles to Herdmann's bibliographic list in his *Challenger* reports, which has been the standard bibliography for the Tunicata.

The bibliography is in the form of an author's index with full titles, with page references, and often with brief note as to contents. There are included not only works which deal exclusively or mainly with the Tunicata, as indicated in their titles, but very many works in which the reference to the Tunicata is not the main theme, general text-books being included in the list. Of course, no such list can possibly be entirely complete, but in this instance it is a remarkably full one and will be of great value to students of the group.

In several weeks' use of the bibliography the reviewer has noticed no inaccuracies and no omissions of any moment. It is a little unfortunate that about a tenth of the titles are placed in a supplementary list.

MAYNARD M. METCALF

OBERLIN, OHIO,
October 1, 1913

The Earth: Its Genesis and Evolution Considered in the Light of the Most Recent Scientific Research. By A. T. SWAINE. London.

Worthless is a very strong adjective to apply to a book which is almost a model in paper, typography and illustration. Yet just what is the value of a book whose author believes that vital force produces matter (p. 72), that thus the earth is slowly growing larger (p. 263), that the great cycles of sedimentation correspond to a filling up of the great ocean depths, a straw-colored siliceous ooze below 3,000 fathoms and red clays corresponding to the basal quartzites and red beds (p. 20), that up to the close of the Paleozoic the light and heat energy of the sun had not been experienced on earth (pp. 144–151), but that an increase in temperature of the earth's crust in cycles was due to igneous activity and outflow of heat from the interior, which evaporated a large amount of the ocean (pp. 89, 95, 109, 174, 183, 193)? Compared with these heresies, the theory that sedimentary rocks are fused sediments (p. 54), that erosion and conglomerates are largely due to the wash of the evaporated ocean condensing again (p. 95) with the tidal waves caused by earth movement paroxysms (pp. 186, 213), the explanation of transgressive formations (p. 95), of laterite (p. 199) and of drumlins (p. 245) are but minor. The book shows, however, a wide acquaintance with recent and the best geological literature, though it is curious in a book that dwells so much on geologic cycles of sedimentation that no mention seems to be made of Newberry or Schuchert. It contains a mass of geological fact mixed with the author's unique views put in an interesting way.

Conceivably, it might be of use to give to a rather advanced student, inclined to swallow what he reads too easily, as an emetic, asking him to show why the facts advanced by the author do not support his theories.

ALFRED C. LANE

SCIENTIFIC JOURNALS AND ARTICLES

THE first number of the new *Journal of Agricultural Research* published by the U. S. Department of Agriculture was issued October 10. It consists of eighty-seven pages of letterpress and line drawings and five plates, including one color plate. The articles in the first number are:

"*Citrus ichangensis*, a Promising, Hardy, New Species from Southwestern China and Assam."

"*Cysticercus ovis*, the Cause of Tapeworm Cysts in Mutton."

"The Serpentine Leaf-Miner."

In the introduction, written by Dr. B. T. Galloway, assistant secretary, the purposes of the journal are explained as follows: "The recent advances in the theory and practise of agriculture have come almost entirely from scientific research applied to agricultural problems. Accumulated results of centuries of painstaking studies have been drawn upon, and it has become evident that further improvement in agriculture calls for continued investigation of the most accurate and thorough nature. The first recognition of the economic value of progress in these investigations as well as the initial application of theories to practical prob-

lems comes usually from specialists. Indeed, only in rare instances is the significance of the results of scientific research apparent to farmers, since newly discovered facts are seldom directly applicable to agricultural conditions. The suggestive or the indirect value of reports of new work is usually of paramount economic importance; it is the purpose of the *Journal of Agricultural Research,* therefore, to record investigations bearing directly or indirectly upon economic conditions of agriculture." According to the foreword the journal for the first few issues will contain papers from the Department of Agriculture only. The later numbers, however, will probably include articles prepared and submitted by investigators in the state agricultural colleges and experiment stations. The book is highly technical in character and will not be circulated except among scientific specialists.

OCEANOGRAPHIC CRUISES OF THE U. S. FISHERIES SCHOONER "GRAMPUS" 1912–1913

IN the advance of the modern science of oceanography the coastal waters of the eastern seaboard of the United States have received little attention. But the introduction of new fishery methods, and the frequent reports of a diminution of food fishes along our coast add an economic to the purely scientific need for a close study of the physical features, and plankton, of our waters, such as has long been prosecuted in the North Sea by the nations bordering upon it. A beginning has been made along these lines by the U. S. Bureau of Fisheries, with the cooperation of the Museum of Comparative Zoology. And during the past two summers the Fisheries schooner *Grampus* has been detailed, in my charge, for oceanographic cruises which have so far extended from Nova Scotia to Chesapeake Bay, a brief outline of which is given here. In both years Mr. W. W. Welsh, of the bureau, has acted as my assistant.

In a sailing vessel, which the *Grampus* is primarily in spite of a small auxiliary gasoline engine, oceanographic work is necessarily carried on under difficulties. But there was no steamer available. And fortunately we have enjoyed such exceptionally fine weather on both cruises that we worked to better advantage than might have been expected. Such operations as require the vessel to be stationary for any length of time, for example current measurements, were usually performed from a dory at anchor, though occasionally, if the sea was too rough, we anchored the vessel herself for this purpose. For hoisting purposes a gasoline winch was installed on deck. The equipment of the *Grampus* consisted, in 1912, of Negretti and Zambra reversing deep-sea thermometers, a Sigsbee and a stopcock water bottle; an Ekman current meter, a closing net for horizontal towing, described elsewhere,[1] quantitative nets of the Hensen pattern, a variety of ordinary tow nets, large and small, of various grades of silk, and an eight-foot beam trawl.

In 1913 we added a second current meter, two more stopcock water-bottles, a Helgoland "shear board" tow net, which proved to be the most effective of our nets, a three-foot tow net of the *Michael Sars* pattern and a Lucas sounding machine. On the other hand, we discarded the Sigsbee water bottle, which proved unreliable, and substituted an otter trawl for the beam trawl, a change which proved very advantageous.

In 1912 our cruise lasted from July 8 until August 31. We chose the Gulf of Maine as our first field of work partly because of its important fisheries, partly because it was nearly virgin ground so far as sub-surface temperatures, salinities and plankton were concerned, but chiefly because, being a partially isolated area, a comparatively complete survey could be made in the time at our disposal. The stations were planned to include Massachusetts Bay, the deep basin off Cape Ann and Cape Cod, the coastal waters and off-shore banks along the coast of Maine, and a line from Cape Elizabeth to Cape Sable, while a week was spent trawling in and near Casco Bay in cooperation with the Harpswell

[1] *Int. Rev. Hydrobiol. Hydrogr.*, 5: p. 576, 1913.

Marine Laboratory. During the cruise forty-six off-shore stations were occupied, at which 130 tows were made with the various nets; quantitative hauls were made at sixteen stations; the dredge or trawl used at fourteen; serial temperatures were taken at thirty-nine, bottom, intermediate and surface water samples at 37, while 38 current measurements were made. The surface temperature was recorded hourly, and the color of the sea noted by the Forel scale.

On our return to port the salinities of the water samples were obtained by titration with nitrate of silver, the use of floating hydrometers having been abandoned as wholly unreliable.

In November, 1912, operations were resumed on the steamer *Blue Wing*, which acted as tender to the *Grampus* during her fish-cultural operations of the winter. By the courtesy of the Bureau of Fisheries I was enabled to make stations on the *Blue Wing* bi-monthly until April, 1913, in Massachusetts Bay, taking the usual serial temperatures, serial water samples and tows. And during March, April and May, 1913, this work was greatly advanced by Mr. W. W. Welsh, of the Bureau of Fisheries, who took temperatures, water samples and surface tows at numerous stations between Cape Ann and Boon Island, while investigating the spawning habits of the haddock.

We laid out a more ambitious program for our summer cruise in 1913 than in the preceding year, planning to cover the cool coastal water between the coast and the Gulf stream, from Cape Cod to the mouth of Chesapeake Bay, besides repeating, in a general way, our stations of 1912 in the Gulf of Maine. The object of the latter part of the work was, of course, to trace the changes which might take place there from year to year.

On July 7, the *Grampus*, again in my charge, sailed southward from Gloucester. And we were now able to work in much greater comfort than before, an excellent laboratory having been constructed on board during the winter. Our course took us to the western edge of Georges Bank, where we made our second station, thence directly to the edge of the Gulf stream south of Nantucket Shoals Light Ship. We then proceeded southwestward along the coast in a zigzag course, occupying a station every 45 miles or so, and running three sections across the coastal bank to the Gulf stream over the continental slope. On July 24 we reached the Chesapeake, and anchored in Norfolk to refit.

During this part of the cruise three stations were devoted to current measurements, off Long Island, Cape May and Chincoteague, observations being taken hourly, at surface and bottom, for six hours at each station. The first was timed to include parts of both flood- and ebb-tides, the last two together covered an entire flood and nearly an entire ebb.

We left Norfolk July 29, reached Gloucester August 4, and put to sea again for the Gulf of Maine on August 9. We now ran from Cape Ann to Cape Sable, and besides making stations en route, turned aside to visit Jeffreys Bank and the deep trough off Platt's Bank. We then turned northward, crossing the mouth of the Bay of Fundy, and followed the coast back to Gloucester, where we arrived on August 15. During the summer's cruise complete oceanographic observations, including serial temperatures and serial water samples, were taken at 50 stations. And thanks to our ample supply of water bottles, water samples were taken at from 3 to 5 levels at every station. One hundred and sixty-five tows were made with the various plankton nets, including 15 hauls with the quantitative net, the latter all in the Gulf of Maine, and the otter trawl was used at 10 stations. It may be of interest to note that the distance traveled was about 2,100 miles.

The plankton collections gathered during 1912 and 1913 are very extensive, and as varied as the large ocean area traversed would suggest, fish fry and eggs, copepods, hyperiid amphipods, schizopods, sagittæ, pteropods, medusæ and diatoms being especially well represented. And the oceano-

graphic data afford a fairly comprehensive survey, for the summer months. As yet our winter data are confined to Massachusetts Bay, and the region just north of Cape Ann, but it is proposed to continue the work at other seasons in future years. The reports on the oceanography, with preliminary accounts of the plankton, are being prepared in the Museum of Comparative Zoology, those for the summer of 1912 being now in press. And the more important groups of pelagic organisms have been distributed to specialists who have undertaken the task of reporting on them.

It would be premature to discuss the scientific results of the cruises here. But passing notice may be called to our demonstration of the fact, long ago suspected by Verrill, that the low surface temperatures of the northeastern part of the Gulf of Maine do not indicate the direct influence of an Arctic current, as has so often been suggested, but are merely the evidence of the strong tidal currents, which cause a more or less complete vertical mixing of the water. Where the gulf is coldest on the surface, it is warmest at the bottom, depth for depth, and *vice versa.* This process reaches its extreme in the Grand Menan Channel, and on German Bank, where the physical characters of the water are practically uniform from surface to bottom. Mention has already been made in the daily press of our discovery of extensive beds of the sea scallop (*Pecten magellanicus*) off the coasts of New York, New Jersey and Maryland. And this promises a new fishery of such importance that the *Grampus* was dispatched southward once more, on August 20, 1913, in charge of Mr. W. W. Welsh, for a two weeks' survey of the beds.

Henry B. Bigelow

Harvard University

SPECIAL ARTICLES

ECTO-PARASITES OF THE MONKEYS, APES AND MAN

For several years I have been urging the thesis that the host distribution of the wingless, permanent ecto-parasites of birds and mammals is governed more by the genetic relationships of the hosts than by their geographic range, or by any other ecologic conditions. In numerous papers, and particularly in a recent[1] one surveying all the known records of the occurrence of Mallophaga on birds, I have offered evidence to support this thesis.

Now, if this contention is sound, the converse of the statement is also true. That is, the kinds (genus, species, etc.) of permanent ecto-parasites found on birds and mammals will indicate in some measure the genetic relationships of the hosts. If, for example, ornithologists have before their eyes certain birds of doubtful relationships, as the hoatzins of South America, or the whole family of owls, they may well pay respectful attention to the kinds of ecto-parasites harbored by these hosts. I have, indeed, pointed out, in the paper just referred to, some suggestive specific cases of this sort.

The wingless, permanent ecto-parasites of birds and mammals are of two groups, namely, the biting lice, Mallophaga, feeding on the feathers and hair, and the sucking lice, Anoplura, feeding on blood. Certain mites (Acarina) may perhaps also be assigned to this category of permanent wingless parasites, but the fleas can not be, for they hop on and off their host, and all their immature life is non-parasitic and wholly apart from their future hosts. The Mallophaga, of which nearly 2,000 species are now known, occur chiefly on birds, while the Anoplura, of which less than 100 are known so far, are confined to mammals.

As my own study of these ecto-parasites has been almost exclusively restricted to the Mallophaga I have not been able to illustrate or bolster up my thesis with many examples derived from conditions among the mammals, but the recent careful work of Fahrenholz (Hanover) and Neumann (Toulouse) on the determination and distribution of certain genera and species of Anoplura makes it possible to point out an especially interesting case of host and parasitic relations which is

[1] "Distribution and Species-Forming of Ecto-Parasites," *Amer. Nat.*, Vol. 47, pp. 129–158, March, 1913.

highly pertinent to the thesis and its converse or corollary, as worded above. This case is that of the sucking lice (Pediculidæ) of man, the anthropoid apes and the tailed monkeys. As no biting lice (Mallophaga) have been found on man, nor on any anthropoid, and only two species, so far, on the lower monkeys, no evidence from their distribution can be derived to confirm or contradict the evidence from the occurrence of the Pediculines.

The situation is this. Sucking lice of species representing two genera, *Pediculus* and *Phthirius,* occur on man. Of the second genus but one species is known, and this is confined exclusively to *Homo.* Of the other, *Pediculus,* six species (perhaps five and a variety) are known of which two (or perhaps, as Neumann holds, one and a well-marked variety) occur on man and only on man, while one is found, and exclusively, on the chimpanzee, another on the gibbons (two species of gibbons), and two on monkeys of an American tailed genus, *Ateles.* On the other tailed monkeys are found several Pediculine species of two distinct genera, *Pedicinus* and *Phthirpedecinus.*

It is gratifying—to the upholder of my thesis—to find man and his cousins, the anthropoid apes, harboring and really characterized by parasites of such near relationships, while when the leap from the anthropoid to the lower monkeys is made—a leap notoriously greater, from a genetic point of view, than that from man to the anthropoids—the parasites are found to be of other genera. Only the *Pediculus* species on *Ateles* seems to be a disturbing exception. But it is precisely the monkey genus *Ateles* which offers a special taxonomic problem to students of the primates. Friedenthal (of serum precipitins fame) has affirmed that on a basis of blood and hair comparison *Ateles* shows unmistakable differences from other tailed monkeys, and resemblances with the anthropoids, and he suggests that in *Ateles* we should see monkeys that, in a certain sense, replace, in the new world, the anthropoids.

The above is the situation as Fahrenholz works it out. Neumann believes that the typical, man-infesting parasite species, *Pediculus capitis,* should include not only the other man-infesting form, *P. corporis,* but also perhaps one of the *Ateles*-infesting forms (*P. consobrinus*). And he is inclined to credit *Pediculus capitis* with a tendency to pass from man to man-apes and monkeys in menageries, and to persist on these new hosts. If *capitis* can do this, then that in itself is a curiously strong indication of the genetic affinities of these various hosts, because both the Mallophaga and Anoplura are curiously sensitive to differences in host blood or host hair and feathers. I have often become, in the course of collection, the temporary host of various bird- and mammal-infesting Mallophaga, but these parasites all seemed as anxious to escape as I was to have them. And they did escape; or, if they did not, they died in a few hours. There is, indeed, an extraordinarily exact fitting of parasite to host in the case of Mallophaga and Anoplura. It is hard to understand of just what details this fitting consists, beyond such more obvious, and insufficient, ones, as number and shape of claws, number and character of clinging spine-hairs, etc. The essential fitting is far more subtle. It is a fitting to the host's physiology as well as to its epidermal structures.

Anyway, Neumann has not known all the cases of the taking of *Pediculus* specimens from the man-apes and from *Ateles,* and some of these cases are beyond the explanation of casual straggling in menageries. For some of the ape hosts were not in menageries.

There is no doubt that man is host to certain permanent, wingless ecto-parasites which find their closest relatives in parasites of the man-apes and of a problematic lower monkey. And this evidence from commonness of parasites adds itself to the already acquired great mass of other evidence from conditions of structure, blood serum reactions, crystallizable proteins (hemoglobins), and the rest, that bind us so unescapably in close genetic relationship with the anthropoids.

VERNON L. KELLOGG
STANFORD UNIVERSITY,
CALIFORNIA

SCIENCE

FRIDAY, OCTOBER 31, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE APPEAL OF THE NATURAL SCIENCES[1]

AGAIN the revolving year brings us all together at the opening of the autumn term. And yet not all—no university gathering is ever the same in two successive years. Since last September a thousand and yet again a half a thousand earnest young men and women have left us and have gone to all quarters of the earth to take their places in the world's work. To us who remain their faces have become a cherished memory; their future efforts are a subject of confident trust. Twelve months before there were a thousand and *less* than half a thousand; and as our minds run backward over the earlier years we recall the time when the departing graduates were numbered by hundreds, still earlier by tens; at the very outset, in the small beginnings of colonial days by units. At this the opening of the one hundred and sixtieth year of the institution's life, we hark back to the past more naturally than we would were the year drawing to its close. At Commencement, eyes are turned toward the future; but as we gather ourselves together for renewed effort eyes may be most fittingly for the moment turned toward the past.

It seems a far cry from the Columbia of to-day to the Kings College of 1754, hovered under the wings of Trinity Church in the little colonial town. Much has happened meanwhile and vast changes in conditions, in population and in magnitudes of all sorts have come to pass. But the succession is unbroken. We recognize ourselves to be the end members in a long and honorable line. We may for the moment put our-

1 Address delivered at the opening exercises of Columbia University, September 24, 1913.

selves somewhat in the frame of mind of the Orientals to whom the worship of ancestors is a vital part of life, and we may endeavor from our line of ancestry to draw strength and inspiration for the year's work.

We can do so the more readily because the newness of these buildings is wearing off. Year after year great meetings have been held in this room until its aspect is becoming familiar and it is associated with the feelings of uplift which great audiences give. Ivy begins to cover our walls; while tradition, inheritance, the priceless influence of the past more and more assert themselves. They are indeed one of the great possessions of the university, to which, amid omnipresent change and newness, despite incomparable improvement and convenience, we are prone sometimes to be less sensible than we ought. Let us then run back to the earlier days in the natural sciences in the old Columbia and let the masters of those times make the first appeal for their beloved pursuits.

A century and a half ago the "natural sciences," as the various branches were collectively called, were given less recognition in systems of education than became the custom later. The very name "natural" is itself an interesting commentary on the habit of thought of the time. There were "natural" and "revealed" religion; "natural" and "intellectual" philosophy; the "natural" man, much to his discredit, was contrasted with the "spiritual" man. Even in my own schoolboy days we studied "natural philosophy" instead of physics. The point of view, bred especially in the cloisters, that there was something vaguely wicked about the great world of the out-of-doors had not been outgrown. All will recall that curious phase of thought, current to a certain degree among the ancients, still more generally developed among the people of the Middle Ages, and still strong among ignorant and superstitious peoples to-day, which ascribes something uncanny, harmful, and even demoniacal to the phenomena of nature. Deep ravines, dark recesses of the woods, gloomy caverns with their hordes of devilish-looking bats, the very darkness of night itself, and many other perfectly innocent and to us irresistibly attractive objects of study were looked upon by our forefathers as things accursed. The old habits survive for us in many a story and legend; they have furnished the charm of operas, as in the Freischütz and Tannhäuser; and they cast an interesting side-light on the men and times of the past. But it has taken many years to outgrow them and their germs are part and parcel of us to-day. Our forerunners in natural science had to contend with them, and they were very real obstacles in the way. They were not without their influence on courses of study and in marking the channels in which the currents of instruction ran.

Education in the old days, as we all know, was chiefly work in languages, literature, mathematics and so-called mental philosophy. The subjective mind was the all-important point of attack. The objective universe gained recognition later.

In the eighteenth century in America, the natural sciences received organized care and oversight first in Philadelphia, then the chief American center of intellectual and social life. Benjamin Franklin founded the American Philosophical Society in 1769, the pioneer of our scientific associations, an ancient but still vigorous body, in which, membership to-day is one of the chief prizes for men of science in this country. Eleven years later came the American Academy of Arts and Sciences in Boston. In 1812 the Philadelphia Academy of Sciences was organized; and five years thereafter the New York Lyceum of

Natural History, now the New York Academy of Sciences, made the fourth of our vigorous scientific bodies. It is extremely interesting to read the books of travelers who visited these three cities in the early decades of the last century and to note their comments upon the meetings of the societies mentioned and upon their collections and general activities. The New York Lyceum of Natural History with its building on Broadway near Spring St. was the scene of many an animated gathering.

There is great satisfaction in noting the attention to natural science which was given in the early days of Kings College. It was really greater than was often the case. President Samuel Johnson, an accomplished classical scholar, constituted the entire faculty when instruction began for eight entering students, July 17, 1754. The next year he was aided by his son William, like himself a graduate of Yale. William Johnson was a fellow or assistant tutor; but the first actual professorship was that of mathematics and natural history, to which in 1757 Daniel Treadwell, a graduate of Harvard, was called. Professor Treadwell, by agreement, taught the senior classes "Mathematics and Natural Phylosophy," and the youngest class, Latin and Greek. The establishment of the medical school ten years later added to the staff a professor of chemistry and the materia medica. When the War of Independence had passed and efforts were made to resume instruction in 1784, the College had an annual income of £1,000. A movement arose to increase this amount and to establish seven professorships, viz., Latin, Greek, moral philosophy, rhetoric and logic, mathematics, natural philosophy and astronomy. We scientific men may note with a wee bit of wicked satisfaction, that it was proposed to give the professors in Latin, Greek and moral philosophy, £100 yearly; the professor of rhetoric and logic, £50; while the three professors in the sciences were each to receive, £200. During the closing decades of the eighteenth century, instruction was also given in geography, in botany, and, in 1792, a chair was established of "Natural History, Agriculture and the Arts dependent thereon." It was held by Dr. Samuel L. Mitchill, one of the leading citizens of the city, later member of Congress, and first president of the Lyceum of Natural History.

The foundation of the School of Mines, whose fiftieth anniversary we are planning to celebrate next May, placed the natural sciences upon the firmest foundation which they had possessed up to that time; and while we look back to the earlier names of Mitchill, Hosack, Adrain and Torrey with veneration, we feel that in the inner circle of the college and the closely associated enginering school, the names of Egleston, Chandler, Newberry, Rood and Van Amringe are the ones that make the strongest appeal.

The lives and works of those who have gone before exert a very powerful pressure upon us to maintain the traditions and to pass on to our successors in undiminished importance what we have received. But these influences are active only upon those of us who are year after year in the university. They can not furnish the appeal to the young men and women who come to us and to other institutions for instruction. It may not be inappropriate therefore to also consider at the outset of the year the various forces which turn them toward the natural sciences and then the effect of these studies upon minds and characters. It is a subject in which I have long been interested and which I have followed up by the reading of biographies, by conversations with many of the older scientific men and with younger workers. But all of us teach-

ers of science, who for periods of years have had young men come to study with us our favorite subjects, have inevitably noted the various influences which have prompted them to do so.

Some young men are naturally hunters or fishermen and become thereby attached to outdoor life. An obscure inheritance from some far-off ancestor, who was forced to hunt or to fish for the necessaries of life, may ofttimes assert itself. The latent savage in us, in so far as it may revive and lead to a life in the open, is to be cultivated and developed rather than to be suppressed and bred out. No one, young or old, can roam the woods or fish the streams, the lakes or the ocean, without forming a profound attachment for these surroundings. The pastime of the free days of youth brings into the field of view possible subjects of study for maturer years and occasionally for a life-work. If a youth possesses a studious, thoughtful and reflective type of mind, he is drawn well-nigh irresistibly to continue in these ways. Dr. Henry van Dyke, in one of his charming sketches, describes the taking of his first trout under the guidance of his father, and the deep impression which it made upon him. So many similar experiences followed, with close comradeship between father and son, as to lead our delightful author to wonder, in a mood of whimsical and touching fancy, if somewhere in the Elysian Fields of the future the comradeship will not be resumed. One can not but suspect that it must have been a close decision in his early life whether the youthful van Dyke should become a clergyman or a naturalist; or, as the result proved, a happy combination of both.

Some young men have not roamed the woods or fished the streams for sport in their earlier years, but have been naturally of observant and accurate habit of mind and have been accustomed to note likenesses and differences. The plants, the animals, the minerals and rocks have been the objects to which they have turned and upon which they have exercised their efforts. From an early and close acquaintanceship with a limited area they have begun to wonder about the world outside. The longing to know more fully has brought them to the lecture rooms of the university.

Some are natural collectors and bring together minerals or plants or the smaller forms of animal life in private cabinets. Many a lad has worked by himself over his little herbarium, his trays of minerals or butterflies or birds or beetles until the interest thereby aroused has shaped his future life-work. The beauty of crystal form or of plant structure has appealed to a few more susceptible natures and has drawn them to the study of objects whose attractions seemed irresistible. There are, moreover, from time to time, teachers born into the world—men and women with the gift of clear exposition and with the irrepressible call to shape their lives so as to give it free scope. Some turn to languages; some to the subjective thought of the past; some to moral, religious or economic instruction; and some to preach the gospel of the out-of-doors and of the world of nature.

Some men, especially amid the mountains or in the desert regions such as we find in our western states, are born and reared amid the grand and striking phenomena of nature. Great gorges, abrupt precipices or barren wastes may well raise in their minds the desire to know more about these phenomena. We always find the people in such surroundings reflecting on the causes of things about them and groping for their explanation, it may be blindly, until taught the results laboriously attained by earlier students and until they are steadied by the accumulated results of many observers. There are in other regions young men of

naturally inquiring type of mind, human interrogation points, with a consuming desire to discover the reason of things. The currents of human life and action sometimes attract them less than the phenomena of nature. They turn to the latter as the proper objects of their effort. If endowed with that happy but rare combination of an ability to reason logically and closely and yet to let imagination have its revealing play, they may advance the outposts of knowledge in no small degree.

Let me illustrate by the lives of two or three geologists, selecting them because they are less familiar than the youth of some of the more widely known names in other branches and are therefore possessed of freshness and newness. James Hall, our famous New York state geologist of other days, was a lad in Hingham, Massachusetts, near Boston. Hearing that a school had been started near Troy, N. Y., where natural sciences were especially taught, and having slender resources, he walked from Hingham to Troy and began his studies. He roamed the hills around the little city of the upper Hudson valley, collected the plants and animals, became a teacher in the school and ultimately the official of this and other states. He devoted his mature years to the description and illustration of the dead and gone life of the past with such skill that his works are among America's greatest contributions to science. Peter Lesley, the famous state geologist of Pennsylvania, was a graduate of the Andover Theological Seminary. From failing health he gave up a settled pastorate and became a distributor of bibles in the remoter hills of New Jersey and Pennsylvania. Walking from cabin to cabin of the mountaineers, his eye caught the wonderful geological structure displayed in this region and he turned to natural science; never losing, however, that love of his fellow man which first directed his steps to the mountains as a colporter of sacred books. Newberry, our old-time and distinguished professor, was a boy amid the coal mines owned by his father in eastern Ohio. The wonderfully preserved ferns in the beds associated with the coal interested him profoundly. In later life he tried to curb his natural tendencies and practise medicine in Cleveland, but after five years he gave up the struggle and became naturalist to several successive exploring parties, sent out by the federal government in the West. After the Civil War he was called to be one of the half dozen professors in our School of Mines. He was our first native-born student and describer of the floras of past geological time.

There come also to our class-rooms young men of able and gifted minds, but as yet with no positive inclination toward any special line of work. The influence of some teacher who has the divine fire may arouse latent interest and ambition so that a career of good and serviceable work opens out. To this last group who enter the class-rooms without special call for the future and whom a teacher can influence for a few months, it is all-important, whether they follow science or not, to present in addition to the hard facts of the subject as many of its great truths and generalizations as possible. We should leave some deep imprint which they can never forget. The conception of the earth, for example, as the product of the long, long interplay of many forces, is one which can be readily driven home. The rise and fall of continents, the advance and retreat of oceans, the records of the more recent, and then of the remoter, and finally of the most ancient past, which have now been brought into orderly sequence, convey an impress which, once stamped, can never be effaced. When, therefore, the future lawyer, physician,

clergyman or merchant travels and looks upon mountains, plain and ocean, they mean something to him, and his intelligence grasps them in a way not only to add to his enjoyment, but to make him a broader-minded and better member of human society.

The effects are the same with other branches of natural science. Even from elementary work with plants and animals, some grasp can be gained of their kinds and local associations. Some standard of comparison with other regions is afforded such that by an observant eye intelligent parallels can be drawn. No one who has even a superficial knowledge of the plants and trees in our northern states can travel in the north of Europe without being constantly reminded of his home surroundings. The little twin flower, *Linnæa*, growing on the sands and glacial boulders of our northern and Canadian mountains, has removed the homesickness from the heart of many a Scandinavian settler and has made him feel as if the world was very narrow, after all. And thus arise the questions of animal and plant dispersion. Why is it that they are so nearly the same on opposite sides of the ocean or that one little vine, with the most delicate and fragrant flowers imaginable, can girdle the earth in its northern latitudes?

Again, if with collections and with field experience we can bring home to an intelligent student that one species of plant or animal shades off through close relatives and similar varieties into others and so on to others more remote, so that, although we recognize the entire unlikeness of the widely separated members, we hardly know where to mark a break in the series, a new and startling view of nature is gained. Or, if we find difficulty in bridging some of the gaps among the surviving species on the earth to-day and appeal to the evidences of the fossil past so as to show converging lines of ancestry, the organic world takes on new aspects and an orderly, reasonable and understandable character, not possessed before.

The strongest, most striking, and most readily received impression of all is the one given by the heavens. The sun and moon, the planets and the more distant fixed stars, set as we know them to be in orbits capable of exact mathematical expression; open to our view in all parts of the world; equally visible from land or sea; and best of all in the clear atmosphere of the desert; make the profoundest impression and the strongest appeal of all the branches of natural science. The enormous distances, the order and precision, the series from glowing nebulæ to dead, cold bodies, the vast stores of energy radiating into space, stimulate an inquiring mind as does no other branch of natural science. We are face to face with the origin and development not alone of one world, but of many worlds, indeed of the universe itself.

But there is one additional appeal from the natural sciences which in a fairly new and rapidly developing country like our own is particularly strong to the minds of young men. It was not altogether by chance that the natural sciences received recognition in the medical school of Columbia College in 1767 nor that they were first placed solidly on their feet with the establishment of the School of Mines in 1864. The appeal is based on their useful applications and the assistance which they can give to the practise of medicine and surgery and to all branches of engineering and manufacturing. There was formerly a disposition to think lightly, sometimes even scornfully, in university circles of the applications of our natural sciences and to conclude that if a professor or student once became influenced by them he lost his ideals

and his devotion to pure investigation. But I think we have outgrown this narrow point of view. Not so very many years have passed since the brilliant course of lectures delivered at this university by the late Professor James, in which he set forth the principles of pragmatism. That is, if I understood them correctly, he applied to systems of philosophy and all manner of doctrines very much the same tests that we use for all sorts of useful devices. Will they work? Will they do good service? Are they worth while? Some have at once concluded that pragmatism restricts idealism and minimizes respect for grand truths which stand eternally whether they are of service to mankind or not. Possibly in connection with the last results of mathematical reasoning there may be ground for the criticism. On the other hand, there is much to be said in favor of the check which the pragmatic point of view puts upon vain and idle lines of thought, leading nowhere; in favor of the curb placed upon the putterer in the fields of intellectual activity; or, to use another figure, in favor of the jetties by which it keeps the current of thought in safe and deep channels. Our colleague Professor Fullerton has shown in his recent stimulating work, that in all philosophical reasoning we must take into account that great body of human experience and its resulting influence on habits of thought, which is the common heritage of every man. To be intelligible and to exercise an effective influence, the work of a teacher is blocked out by these all-important considerations.

It is no reflection on the natural sciences, therefore, that they do good service to our modern civilization, nor need the students and teachers of them feel otherwise than proud that their studies have been of service to mankind. The investigator into the minute forms of life, whether of plant or animal, has often found his inspiration in the hope that his results might decrease disease and relieve human suffering. The worker upon the larger forms of plants and animals has multiplied in extraordinary degree the foodstuffs and fabrics. The close study of minerals and their occurrences in nature has added to our mines and supplies of the metals. Even the very fossils in the rocks, the type and symbol in the minds of many for the useless and the negligible, have in the hands of the geologist been of indispensable assistance in selecting the best course for a great, new aqueduct which is to supply our metropolis with its necessary water.

Now the belief that what a student learns, both of scientific fact and doctrine, will be of service to him in his future profession in medicine, engineering or kindred lines, is a very strong and a very worthy appeal. It draws not a few to our courses of study and makes of them diligent workers in the class room and laboratory. That instructor will gain the best results who, while abating in no particular the thoroughness of his presentation, yet slips in the pregnant illustration, which from time to time ties up his subject with the future work of his students. We thus exemplify the truth of the doctrine, expounded in its most general form by Professor Fullerton, that for results we must consider that great body of accumulated experience which has shaped our habits of thought.

In referring to the useful, I do not mean to limit the field merely to the satisfaction of material wants. To enlarge the life of the spirit is, when gaged by its results, as beneficial a service to humanity as to feed the hungry, clothe the naked or relieve the suffering. But the final values are determined by the fruits.

While I have spoken of the connections

between the natural sciences and the professions of medicine and engineering, there are many points of contact between the student of nature and the artist on the one side and the poet on the other. As between the first two there is the consuming ambition to faithfully depict what one has seen. The scientist does it with descriptions, fortified more and more in later years with pictures. The descriptions reproduce for a person at a distance the object before the actual observer. They record for the future the fleeting things of the present. In so far as the artist deals with the actual rather than the imaginary, his ambition is likewise to give true and accurate impressions, and by his medium of expression to convey his thought to others. The record is indeed not for comparison with the original at some future time, as it is with the scientific man, and it appeals rather from its own intrinsic merits than because it places objects in systems of classifications or shows them to conform to law, but the inspiring motive or ideal which holds each to the proper fulfillment of his task is the same. Wielders of the brush or of the chisel often become as thorough masters of bone, muscle and form as the professional anatomists themselves. The portrayers upon canvas of mountains and canyons must be true to geological structure as much as if they were geologists. Ruskin, you will recall, has emphasized this truth in one of his essays. Sometimes the portrayer of landscapes and the geologist strike hands and work together. Thomas Moran, the artist, was in the party of Clarence Dutton, the geologist, when the Grand Canyon of the Colorado was studied thirty years ago. They greatly aided each other and sometimes when we read the word-painting of Dutton and view the color-portrayal of Moran, we hardly know which was the greater artist. Certainly both were profoundly moved by their surroundings and singularly gifted, each in his own medium of expression.

One soon learns from the lives of geologists that over and over the masters of the subject have turned to their sketch-books and pencils to faithfully record what they saw in the field. The excellence of the portrayal leaves us sometimes in doubt whether they were the more artist or scientist. Indeed, we may wonder, if after all when the real master appears the two terms are not synonymous. Deep down in the fundamental inspiration of each you will find an identical substratum.

The close relations between the student of nature and the poet, I fancy, you will find less easy to establish, and yet there is much in common. The parallel may be first drawn between the means of expression. The music of verse is based upon orderly mathematical relations as much as the music of notes. In fact the two are not far apart in this primary feature, and the appeal of each to the ear is based on the fondness of our minds for just this orderly arrangement of sounds and accents. The order and the harmony are necessary; otherwise we are in revolt. The student of plants, animals or minerals seeks to classify them all in natural and related groups. The relationship, the conformity to law, the harmony thus displayed are what appeal to him. Through drudgery, hardship, effort without limit, they carry him unfalteringly to his goal. The geologist seeks the laws which govern the phenomena of our material earth; while the astronomer deals with the forces of attraction which bind the universe in a united whole. The words of a poet and the phenomena of a naturalist fall into very similar relations. But back of the words of the poet and back of the phenomena of the naturalist, there must be in the mind of each an insight into the meaning of things, which is a very rare and very

great gift. Fullness of experience and broad knowledge of the phenomena of human life on the part of the one—equally broad and comprehensive grasp of the phenomena of nature on the part of the other—lead to revelations of otherwise unsuspected truths.

We are not without illustrations. It is really quite impressive that when we come to know the lives of geologists intimately, we very often find them expressing themselves in verse. I doubt not, if we could have access to their notebooks, recorded in the field, we would find many a stanza, in which amid grand scenery the geologist sought to give utterance to the emotions which filled him. Some have actually gone to press. The verses of Perceval, the old-time state geologist of Connecticut and Wisconsin, fill a volume in the works of earlier American writers. Throughout the "Life and Letters of Sir Andrew Ramsey," the late chief of the Geological Survey of Great Britain, we find now a sonnet, again a song, in which his feelings found irrepressible outlet. Only a few years have passed since the late Professor Shaler, the man of great heart and boundless sympathies, long in the chair of geology at Harvard, gave us five entire volumes of dramas, reproducing the Elizabethan period, and all in verse. His thought found metrical expression with great ease and fluency. His geological training, with its broad sympathy with nature, was far from an inappropriate preparation for the task. To come nearer home, we will many of us recall that from the severe mathematical and scientific training of our School of Mines, have come two of the most graceful and appealing of our modern American writers of verse. It is rare that stanzas go so straight to our hearts as do theirs. Indeed, unless the student or investigator of scientific problems has in his composition some infusion of the divine fire, his work never rises above the humdrum and the commonplace. He *must* at times feel his heart burn within him as he walks the ways of his chosen calling.

Many, as I have mentioned, follow courses of study in the natural sciences from interest in the subjects, but the student can not do so without a reflex influence upon himself. He is, for example, obliged by the very nature of the pursuit to be accurate, precise and orderly in his thinking. False observations, careless records or confusion of thought bring no results. Clearness and a remorseless regard for the truth must be all-absorbing. There is and can be no attempt to make the worse appear the better reason; there is no complexity of motive; but simple and direct habits of mind must be cultivated. Results are to be reported to others and are certain to be checked in the future. There is therefore the constant pressure to have them right. An ideal is held before a man which is not without its ethical response. While one can not say that it is always manifested in the lives of scientific men with all the force that we might wish; nor can we say that every one of them is as truthful, direct or accurate as he should be, yet the influences of his pursuits are strong, even if not altogether transforming.

The natural sciences, when not pursued as a life-work, exercise in other respects a most wholesome influence. They serve as a change from other work and as a foil to complete absorption in ordinary employments. People in general are too exclusively occupied with matters which concern their own kind alone. It becomes easy to regard man as the end and object of the universe, the old conception of the teleologists. The dwellers in crowded cities tend to be concerned solely with human, purely human affairs. Brick-walls and pavements,

the clothing, feeding and housing of men, women and children make up the entire round of life, so that for their use the world may have naturally seemed created. This is an ancient and charmingly child-like conception. But when we know something of the earth's complexity, of its wonderful inter-relations, of its long past and of the certain developments through which it will pass in the future, these false notions give place to much more correct perspectives. Man is indeed a member of the great, organic family, but he has his place in the series, just as do all the other members. He plays his part, but so do they. In some respects he is more impressive than other living creatures; in some respects less so. A well-balanced student of natural science accepts these facts and draws no comparisons of superiority or inferiority. He has borne in upon him the conviction that human affairs are not all of the universe, and that he should be neither unduly exalted nor cast down. A calm and steadfast habit of mind should be his and his studies should exercise this disciplinary influence upon him.

The American who has given the best expression to this influence of nature upon man is Bryant. Himself a keen lover of the woods, fields and mountains, he had further the great gift of describing in dignified and musical verse their effects upon him. In his "Forest Hymn" and again in "Thanatopsis" we find these influences beautifully set forth. The calm philosophy which places one apart from the small bickerings and petty things of life rings true in his lines, so that often the words go coursing through our thoughts when face to face with the sublime phenomena of nature.

Bryant, however, is not alone in giving utterance to these conceptions of life. Many and many a naturalist—to use again as I have several times already this old descriptive term for a student of nature—many a naturalist has felt the same and from time to time has set down in his pages the thoughts regarding a philosophy of life, which sprang for utterance while describing material phenomena. We have had within a few years a monumental work from a venerable and greatly beloved Austrian geologist, Eduard Suess. He has discussed the "Face of the Earth"; that is, he has passed in review the entire surface of the earth; its elevations and depressions; their connection with geological structure and time of production; their characters; relationships; systems; causes. He spreads before us a wonderful panorama and casts a flood of light upon its obscurities. But when he comes to his closing sentences he is reminded that his pages are to be read by men and women, and to have their influence upon human lives. Recognizing, therefore, the problems which have been solved and the many others which remain for the future, he sums up in the following words:

> In the face of these open questions, let us rejoice in the sunshine, the starry firmament and all the manifold diversity of the face of our earth, which has been produced by these very processes, recognizing at the same time to how great a degree life is controlled by the nature of the planet and its fortunes.

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OUR RADIUM RESOURCES[1]

THE "wonders of radium," both fact and fable, have been treated so extensively in the scientific and public press that it is not my intention, nor is it at all necessary, to repeat them here. Rather it is my wish to-day to present to a body of men interested in the development of American mining the present commercial situation as regards radium and its ores, and to point

[1] Address to the sixteenth annual convention of the American Mining Congress, Philadelphia, October 20–24, 1913.

out, so far as I may, some of those future developments that already begin to be more or less distinctively visible.

A bulletin on the radium, uranium and vanadium situation, by R. B. Moore, physical chemist in charge of the Denver office of the Bureau of Mines, and K. L. Kithil, mineral technologist of the Bureau, will appear within a few weeks and will contain much detail of interest to the mining industry. Last April an advance statement, authorized by the director, regarding this bulletin, brought out particularly the fact that practically all of the carnotite ore mined in the world in 1912 was shipped abroad and that this country was furnishing annually nearly three times as much radium from its Colorado carnotite deposits as all the rest of the world put together. It was further pointed out that this material has been bought by European buyers at a price entirely incommensurate with its radium value and that efforts should be made to keep at home both the radium itself and the profits of its manufacture; also that too much stress could not be laid upon the extensive waste of valuable radium ore thrown on the dumps of mines and prospects—much of it under such conditions that it could never be recovered.

The publication of this statement has already resulted in an increase of at least 33 per cent. in the price of carnotite ore, and European buyers are awakening to the fact that they must pay to the American miner a price nearer the actual value of his ore. Also, a much lower grade of ore is now marketable, for whereas six months ago ore containing 2 per cent. uranium oxide was the lowest grade accepted by European buyers, agents of these buyers are now asking for and actually purchasing ore containing no more than half this content of uranium. Furthermore, the operators are taking more care in separating their low grade ore from the gangue and in protecting it from wind and weather. Moreover, old dumps are being sold and ore that a few months ago was thrown aside as valueless will be recovered from them.

In this paper I shall refer to other facts contained in this bulletin and shall mention some new developments having a direct bearing upon the American radium industry which have taken place since the manuscript was sent to the printer.

As is well known to all of you, the popular belief has been that the chief source of radium is the mineral pitchblende, especially that obtained from the mines now under the control of the Austrian government at Joachimenthal, Bohemia, and pitchblende is the richest and most eagerly sought uranium radium ore. Outside of the ore in Austria, the only pitchblende deposits of any size are those in Gilpin County, Colorado, from which some thirty tons, more or less, have been procured since the mineral became valuable as a source of radium. The Denver papers recently announced that these pitchblende-bearing mines have been acquired by Alfred I. du Pont, of Wilmington, Delaware, and it is greatly to be hoped that their exploitation under his direction will yield an increased supply of this valuable mineral. It is not, however, so generally recognized that the mineral carnotite, which, outside of the United States, occurs only in the Olray district of South Australia and in low-grade ores mixed with ilmenite as a calcium carnotite (communicated by W. F. Hillebrand) under the name of Tyuyamyunite, in Ferghana, Russian Turkestan, low-grade ore mixed with ilmenite, is by far the more important source of radium. From the most authentic sources it can be definitely stated that the Australian and Russian deposits do not compare in extent or richness with our own. The American carno-

tite is accordingly the largest source of radium at the present time, and at least four times as much radium was mined in America in the form of carnotite in 1912 as has been produced from Colorado pitchblende since it was first discovered in that state.

Outside of carnotite and pitchblende, the only known source of radium is the mineral autunite. The autunite deposits of Portugal have probably furnished a few milligrams to commerce, and from the Mt. Painter deposits in South Australia a few tons of autunite-bearing ores have been shipped to London.

American carnotite is found chiefly in Montrose and San Miguel counties, Colorado, and in Utah, northwest of these counties. The Utah deposits are at Green River, Table Mountain, Richardson, Fruita, Moab, and some sixteen miles southeast of Thompsons. The ores of these deposits are of a lower grade than those of the Paradox Valley, but they are nearer to the railroads and transportation costs are much less. The Green River deposits have apparently become regular producers. In Colorado, prospects have been opened at Coal Creek, fourteen miles north of Meeker, and at Skull Creek, sixty-five miles west of Meeker, but the richest of all American carnotite localities and, indeed, the richest known radium-bearing region in the world is that of the Paradox Valley, extending from Hydraulic on the north to the McIntyre district on the south.

Geologists are now in the field making a special study of these carnotite ores with special reference to their occurrence and origin, of which altogether too little is now known. In the Paradox region, the deposits seem to lie invariably just above the fine-grained La Plata sandstone. This rock is usually exposed high on the sides of the canyons, some of which are excelled in extent and in natural beauty by only the Grand Canyon itself. In a few instances, as at Long Park and Club Ranch, the deposits are only a few feet under the surface, the higher formations having been eroded; but for the main part, the stratum in which the carnotite occurs, when not entirely eroded, is deep below the surface of the mass. Accordingly prospecting is mainly carried on along the sides of the canyons, and where vanadium and uranium stains are seen upon the rock the prospector blasts his tunnel in the hope of developing a pocket of the ore. The fact that the ore occurs in pockets renders prospecting uncertain, and there appears to be no present hope of insuring a successful search for pockets that are not exposed, or do not happen to be near the surface. Although it is probable that many other pockets of carnotite occur at the same geologic horizon, their discovery, except where the ore-bearing stratum has been exposed by erosion, appears at present to be an almost hopeless task. The eroded sides of the canyons have been prospected again and again, but new claims are still being opened and are being sold by the prospector to the larger companies or operators who mine the ore. In such a sale the prospector and the purchaser both take a decided risk, for at present no method is used to determine the extent of the ore in the pocket other than the "prospector's hole."

As few of the prospectors of the west are acquainted with carnotite and pitchblende, the following description of the ores has been issued from the Denver office of the Bureau of Mines and is sent to all who make inquiry:

In reply to your letter for information concerning radium ores, the following facts may be of interest:

Radium is found with uranium minerals only. Wherever uranium exists, radium is also found in the mineral; and where there is no uranium, radium

has never been found. Uranium and therefore radium are found in this country in carnotite and its associated minerals, and in pitchblende. Carnotite is a lemon-yellow mineral, usually found in pockets of sandstone deposits. The mineral may be in the form of light yellow specks disseminated through the sandstone, or as yellow incrustations in the cracks of the sandstone; or may be more or less massive, associated with blue, black or brown vanadium ores.

Pitchblende is a hard, blue-black ore that looks something like magnetite, but is heavier. It is found in pockets and veins in igneous rocks. This mineral is not nearly as widely distributed as carnotite. Occasionally it is found associated with an orange mineral called gummite.

The best way to test these ores is to wrap, in the dark, a photographic plate in two thicknesses of black paper. On the paper lay a key and then, just above the key, suspend two or three ounces of the ore, and place the whole in a light-tight box. Pressure of the ore on the key and plate should be avoided. After three or four days, develop the plate in the ordinary way; and if the ore is appreciably radio-active, an image of the key will be found on the plate.

The U. S. Bureau of Mines, 502 Foster Building, Denver, Colorado, will be glad to receive any samples of ores giving promise of containing radium and associated rare minerals, as indicated by the test above described. Though it can not undertake to make chemical analyses or assays of such minerals for private parties, it will indicate the advisability of further examination.

The Colorado carnotite deposits were apparently first noted as far back as 1881, when Andrew J. Talbert mined some of the ore and sent it to Leadville, where it was reported as carrying $5 in gold per ton. This must have been an unusual ore, as the carnotite now found does not carry the precious metal. In 1896, Gordon Kimball and Thomas Logan sent specimens to the Smithsonian Institution, Washington, D. C., and were informed that the minerals contained uranium. Shortly thereafter they mined 10 tons of ore, shipped it to Denver, and sold it for $2,700 on account of its uranium content. Three years later, in 1899, Poulot and Voilleque collected and sent to France specimens which were examined by Friedel and Cumonge, who recognized the existence of a new mineral and named it "carnotite," in honor of M. Carnot, then President of the French Republic. In 1900 Poulet and Voilleque leased carnotite ores at Cashin in the Paradox Valley to extract the uranium. They shortly after completed a small mill in the McIntyre district, south of the Paradox, and in this project had the cooperation of Jas. McBride, a mining engineer of Burton, Mich. Their mill ran until 1902 and during that time produced 15,000 pounds of uranium oxide. The mill was started again in 1903 by the Western Refining Company, but ran only a year. Up to 1904 the mills appear to have been run wholly with the idea of obtaining the uranium and vanadium from the ore, for no radium was extracted. Shortly afterwards the Dolores Refining Company built a new mill a short distance from the old one, but after running for some years, this mill, too, shut down. In 1912 the American Rare Metals Company acquired the mill of the Dolores Refining Company and is now operating it, with the special purpose of obtaining radium from the ores. The first attempt to extract radium in this country appears to have been made by the Rare Metals Reduction Company, under the management of Stephen T. Lockwood, of Buffalo, N. Y. In September, 1900, Mr. Lockwood brought back from Richardson, Utah, samples of carnotite ore and in 1902 he published in the *Engineering and Mining Journal* of September 27 the first radiographic plate from products of American carnotite. In June, 1902, he received 500 pounds of specially picked high-grade ore from Richardson, Utah, and in May, 1903, as a result of experimental work on this ore, he incorporated what was probably the first American company to operate a plant to produce

radium as one of its products. In October, 1903, the first experimental plant was constructed and in April, 1904, the first 17-ton car of ore reached Buffalo from Richardson, Utah. The company obtained a fair percentage of extraction, but the ore proved to be too low grade and the Richardson deposits were abandoned. No radium in concentrated form was put upon the market, although barium sulphate concentrates were produced.

The General Vanadium Company, which, with the Radium Extraction Company, is a subsidiary of the International Vanadium Company of Liverpool, England, was formed in 1909 and began work in 1910, the same year that the Standard Chemical Company of Pittsburgh, Pa., entered the field. Since that time these two companies have been engaged in mining carnotite. The ores from the General Vanadium Company have been shipped almost entirely abroad, while the Standard Chemical Company has shipped several hundreds of tons of carnotite to its works at Canonsburg, Pa. While it was stated at the time of the advance announcement of the bulletin to be issued by the Bureau of Mines, that one American company had actively entered into the production of radium, no actual sale of American-produced radium could be authenticated. Since that time, however, the Standard Chemical Company has entered the American markets.

Besides the American Rare Metals Company and the Standard Chemical Company, a third company—the Radium Company of America, with mines near Green River, Utah—has undertaken the production of radium in its plant at Sellersville, Pa. There is, therefore, every reason to hope that more and more of our ores will be worked up at home.

Besides the companies already mentioned, a number of independent operators mine and ship carnotite from the Paradox region and for the main part send their ores to Hamburg. Among the more prominent of these may be mentioned:

T. V. Curren, Placerville, Colo.

W. L. Cummings, Placerville, Colo.

O. B. Wilsmarth, Montrose, Colo.

David Taylor, Salt Lake City, Utah.

The costs of mining, and especially of transportation, are an important factor in the marketing of carnotite. The Green River deposits have a distinct advantage over the Colorado deposits in this respect, as they are nearer the railroad, but, as their ores do not average so high in uranium, this advantage is more apparent than real. The present cost of mining, sorting and sacking in the Paradox apparently vary from about \$28 to \$40 per ton. To this must be added an \$18 to \$20 hauling charge to Placerville, and, in most instances, an additional charge for burros from the mines to points that can be reached by wagon. The freight rate from Placerville to Hamburg, via Galveston, is \$14.50 per ton so that the average cost at present to the miner laying down his ore at the European markets approximates \$70 per ton. The selling price varies with the uranium content, but is by no means proportional thereto, since a premium is always paid for rich ores. Very recently, however, a decided improvement has taken place and for 2 per cent. ore, the price is now around \$2.50 per pound for the contained uranium oxide, with an allowance of about 13 cents per pound for the vanadium oxide content, so that the 2 per cent. ore will now bring in Hamburg about \$95 per ton. One per cent. ore is now salable, but unless this ore is taken from the dump, so that the mining cost may be disregarded, it will scarcely bear transportation charges from the Paradox, although it is more than probable that it will be soon shipped regularly from the Utah field.

A price of $95 at Hamburg for 2 per cent. ore leaves a fair margin of profit to the miner, as mining profits go, but when it is considered that this price represents only a little over one tenth of the value of the radium content of the ore and that from this fraction of the value the American miner has to meet the outlay represented by the investment, by mining costs, transportation and assay costs and by losses in transit, it seems scarcely just that nearly nine tenths of the value should go to foreign manufacturers of radium, especially when the fact is considered that radium can be produced much more readily from carnotite than from pitchblende. There are two ways of reducing this difference between the actual value of the ore and the price that the miner receives. One is to hold our American ores for a higher price, and the second is to manufacture radium at home.

Large wastes are still taking place in the mining of carnotite, owing to the inability of the low-grade ores to bear transportation charges. As has already been pointed out, however, a distinct improvement in this respect has taken place within the last few months. The miners are beginning to realize the value of their old dumps and are attempting to save the low-grade, non-shipping ore in such ways as will render its marketing possible when prices advance. The Bureau of Mines has done everything it can to impress the necessity of this truest kind of conservation upon the mine operator.

In addition, there is prospect that most of the low-grade ores can be successfully concentrated by mechanical methods and experiments at the Denver office of the Bureau of Mines indicate that a concentration of four to one can be obtained. In this concentration, however, there are losses which could be prevented by chemical concentration, but at the present time it costs more to ship the necessary chemicals to the mines than it does to ship the ores to places where these chemicals can be cheaply obtained. It would appear, however, that mechanical concentration can save at least one half of the material that is now going to waste.

Although, until recently, the manufacture of radium has been carried on almost wholly in France and Germany, there appears to be no good reason why our American carnotite should not be treated at home. Carnotite is much more easily treated than pitchblende and the essential features of methods for its chemical treatment are well known, although much of the mechanical detail of operation has been kept secret. As the mechanical requirements, however, are those which any well-grounded chemical engineer should be able to solve, there seems to be no good reason why any of our carnotite ores should be shipped abroad, even at two or three times the present market price of the material. As before stated, the essential features of chemical methods of extracting radium from its ores are well known. As regards the principles involved, the methods have advanced little beyond the original method published by Debierne.

The methods for carnotite may be described best in the words of Soddy, in an extract from "The Chemistry of the Radio Elements," by Frederick Soddy, page 55, published in 1911 by Longmans, Green & Co.

The most important operations in the working up of radium-containing materials are the solution of the materials, consisting usually of insoluble sulphates and the separation of the halogen salts of the alkaline-earth group in a pure state, followed by their fractional crystallization. The first operation is usually effected by vigorous boiling with sodium carbonate solution, filtering and washing free from sulphate. This is the well-known reaction studied dynamically by Guldberg and Waage, whereby an equilibrium is attained be-

tween the two pairs of soluble and insoluble sulphates and carbonates. Naturally the greater the excess of sodium carbonate the larger the proportion of insoluble sulphate converted into insoluble carbonate. In this operation it is advisable not to wash at once with water, but with sodium carbonate solution until most of the sulphates are removed, as thereby the reconversion of the carbonates back into insoluble sulphates is largely prevented. In dealing with crude materials—for example, the radium-containing residues from pitchblende—it is often advantageous to precede this operation by a similar one, using a sodium hydrate solution containing a little carbonate, which dissolves part of the lead and silica present. The carbonates, washed free from sulphates, are treated with pure hydrochloric acid, which dissolves the alkaline-earths, including radium. From the solution the latter may be precipitated as sulphates by sulphuric acid and reconverted back into carbonates as before, or sometimes more conveniently they may be precipitated directly as chlorides by saturating the solution with hydrogen chloride. This is a very elegant method of great utility in the laboratory, for the most probable impurities, chlorides of lead, iron, calcium, etc., remain in solution and only the barium and radium chloride are precipitated, practically in the pure state, ready for fractionation.

The price of radium appears for some time to have been holding steady at about $120 per milligram of radium metal. This does not mean that the material is bought in the elementary condition, but that the radium chloride and radium bromide, which are on the market, are paid for on the basis of the metallic radium they contain. This method of payment is a distinct advance over the old method of paying the same price indiscriminately for the chloride or bromide. This price of $120 per milligram of the metal is equivalent to approximately $91,000 per gram of radium chloride ($RaCl_2$), or $70,000 per gram of anhydrous radium bromide ($RaBr_2$). Whether this price will rise, fall or remain stationary can not be predicted. There is no question that there is to be an increased radium production and that meso-thorium is also coming upon the markets in increasing quantity, but the uses of and demand for radium are apparently developing at an even greater rate. Furthermore, the supply of the material is limited and no large resources are in sight. Only one estimate has been published of the total quantity of radium in the Colorado carnotite deposits, and that was 900 grams. This estimate is at least five times as large as has been made by any employee of the Bureau of Mines, reckoning all known deposits in the whole American field, even including material too low grade to be marketable. Besides the radium, the uranium and the vanadium present in carnotite are available assets, and recent developments indicate that all the uranium produced will soon be readily sold, while it is well known that there is a ready market for vanadium for vanadium steel.

The value to the public of these deposits is, however, not to be measured in dollars and cents. The value of the radium output of America will never compare with that of several of our common metals. The total value of the radium in the world's output of radium ores in 1912 was little more than $1,000,000. Accordingly, the value must ever be reckoned in what it can accomplish for the public knowledge and the public weal. No certain prediction can be made of the ultimate value of radium, or of its possible applications to science or medicine, but enough has been done to show that radium is worthy of the fullest investigation by our highest scientific and medical authorities. Developments in its application to medicine are coming fast. The foreign medical press contains many apparently authentic reports of cures by its use. Interesting developments are also under way in America, and those who have had the largest personal experience in its use are most enthusiastic over its future application. The public may soon look to impor-

tant publications from leading American authorities, who have had real experience in radium therapy. It is to be greatly regretted that, owing to the high price of the material, only three or four American surgeons have, so far as the Bureau of Mines is informed, been able to use it in quantities sufficient for the drawing of decisive conclusions. In the progress of the future applications of radium to the curing of disease, nothing is more to be feared than its use in nostrums of every kind. The "wonders of radium" have been so extensively exploited in the public press that already the name is being employed as a psychological agent in advertisements of all kinds of materials, many of which contain no radium at all, or, if this element is indeed present, in such small quantities that no therapeutic value can be expected. As bearing on the need of further experiment, attention is called to the fact that the concentrated action of large quantities of radium may effect cures that have been impossible with the smaller amounts heretofore available to the medical profession. It is doubtful if there is at the present time in the hands of the medical profession of America more than a single gram of this rare element, and the results of investigations soon to be published will show that the concentrated action of the gamma rays from several hundred milligrams arrest certain forms of cancer and other malignant growths when smaller quantities are without beneficial effect. It is highly important that the medical profession should also have some guarantee of the material they purchase, even if it is purchased in small quantities, and I am glad to note that the U. S. Bureau of Standards is preparing to standardize radium preparations. As several frauds in the sale of radium have already been perpetrated upon American physicians, they should all require that the quality of the material purchased should be certified under conditions which prevent error.

In closing, I take pleasure in saying that I am authorized by the Director of the Bureau of Mines to announce that a cooperative agreement has been entered into with the newly organized National Radium Institute, whereby the Bureau obtains the opportunity of a scientific and technological study of the mining and concentrating of carnotite ores and of the most efficient methods of obtaining radium, vanadium and uranium therefrom, with a view to increased efficiency of production and the prevention of waste.

The National Radium Institute was recently incorporated with the following officers:

Howard A. Kelly, of Baltimore, President.
Curtis F. Burnam, of Baltimore, Vice-president.
Archibald Douglas, of New York, Secretary and Treasurer.
James Douglas, of New York, and E. J. Maloney, of Wilmington, as additional directors.

The institute has no connection with the mining of pitchblende, details of which recently appeared in the Denver papers. It has, however, obtained the right to mine 27 claims in the Paradox Valley region, among which are some of the best mines in this richest radium-bearing region of the world. Nearly 100 tons of high-grade carnotite have already been procured. Under the agreement with the Bureau of Mines, the technical operations of the mines and mill are to be guided by the scientific staff of the Bureau. Work will begin in an experimental plant to be erected in Colorado, using entirely new methods developed at the Denver office of the Bureau of Mines. Concentration experiments also will be conducted in the Paradox, probably at the Long Park

claims, and if successful will be applied to reducing the wastes that now take place. Within a year at most, the mill operations should make results certain and the extraction of ore and production of radium will then be continued on a larger scale. The separation of uranium and vanadium will also be studied, a contract having already been signed for all of these by-products that may be produced. All processes, details of apparatus and plant, and general information gained will be published for the benefit of the people.

The institute is supplied with sufficient funds to carry out its plans.

The institute has been formed for the special purpose of procuring enough radium to conduct extensive experiments in radium therapy with special reference to the curing of cancer. It also expects to carry on investigations regarding the physical characteristics and chemical effects of radium rays and hopes in time to be able to assist or perhaps even duplicate the effects of these rays by physical means.

Actual experience, especially of the institute's president, in the application of the 650 milligrams of radium and 100 milligrams of mesothorium already in his possession, have led him and his associates to believe that with larger supplies many of the variables that can not now be controlled may be fully correlated, and that radium may become the most effective agent for the treatment of cancer and certain other malignant diseases. Important results have already been obtained by using high concentration of the gamma rays of radium with the alpha rays entirely cut off and the beta rays largely eliminated. Hospital facilities in both Baltimore and New York are already supplied.

The activities of the institute are sure to be of benefit to the prospector and miner by providing a greater demand for his already rare ore; to the plant operator by developing methods and by creating a larger market for his product, and to the people by assisting, and possibly by succeeding, in controlling the most malignant of diseases. The radium produced is intended for the institute's own use and will consequently remain at home.

The Bureau of Mines is especially fortunate in the opportunity to cooperate in the technological features of the work of the institute.

Charles L. Parsons

Division of Mineral Technology,
Bureau of Mines

THE DECENNIAL OF THE DESERT LABORATORY

The tenth anniversary of the establishment of the Desert Laboratory was celebrated at Tucson, Arizona, September 20.

During the day demonstrations of researches in progress were made to visitors, including members of the International Phytogeographic Society, as follows:

10:30 A.M. Suite of Plants in Series of Environic Reactions. By Dr. D. T. MacDougal.

10:45 A.M. Professor W. L. Tower's Experiments on the Influence of Environic Factors in the Evolution of the Chrysomelid Beetles. By Mr. J. G. Sinclair.

11:00 A.M. Researches on Water Relations of Plants. By Professor B. E. Livingston, assisted by Mr. Pulling and Mr. Shive.

12:00 A.M. Certain Features of Correlation Between Climate and Vegetation in the Tucson Region. By Dr. Forrest Shreve.

12:30 A.M. Experimental Studies in the Root-habits of Desert Species. By Dr. W. A. Cannon.

2:00 P.M. Calorimetric Method of Determination of Leaf-temperatures. By Mrs. Edith B. Shreve.

2:15 P.M. Comparative Light Measurements and the Chemical Effects of Radiant Energy in Plant Processes. By Dr. H. A. Spoehr.

2:45 P.M. Exhibition of Progenies of Young Plants Affected by Ovarial Treatments. By Dr. D. T. MacDougal.

3:00 P.M. Water Balance of Desert Plants. By Dr. D. T. MacDougal.

8:15 P.M. Ascent of Tumamoc Hill: Or Drive to Cactus Garden of the University of Arizona. Exhibition of Publications.

In the evening forty scientific men were the guests of the Carnegie Institution of Washington at dinner. Brief addresses were made by Geh. Professor Engler, director of the Royal Garden of Berlin, Professor R. H. Forbes, director of the U. S. Agricultural Experiment Station of Arizona, Professor B. E. Livingston, director of the Laboratory for Plant Physiology of Johns Hopkins University, Dr. Eduard Ruebel, of Zurich, and Dr. D. T. MacDougal. Congratulatory telegrams from President Woodward, Professor V. M. and Mrs. E. S. Spaulding and others were read. The members of the International Phytogeographic Society also presented testimonials of plate to Professor H. C. Cowles, Dr. Geo. E. Nichols and Dr. Geo. D. Fuller.

The members of the society had been the guests of the Carnegie Institution during the previous week at the Coastal Laboratory at Carmel, California, and at the Salton Sea. During the week following the anniversary date, subsistence, tentage and transportation were furnished to a party of thirty traversing the desert to the base of the Santa Catalina Mountains, and making the ascent to the summit of Mt. Lemmon and the Montane plantation. Ample opportunity was given for observations and discussion of factors affecting distribution, including temperature and evaporation gradients, origin and development of formations and the physical and physiological facts implied in conceptions of chaparral, desert, steppe, forest, etc.

The establishment of the Desert Laboratory was authorized by the trustees of the Carnegie Institution late in 1902. Messrs. F. V. Coville and D. T. MacDougal selected a site at Tucson in February, 1903, and after citizens had contributed two hundred acres of land and other concessions a laboratory was erected and Dr. W. A. Cannon as resident investigator took over the building and began work in September, 1903.

The department of botanical research was created by the trustees in December, 1905, and Dr. D. T. MacDougal was appointed director with headquarters at the Desert Laboratory. The equipment has been extended to include the Coastal Laboratory at Carmel, Calif., experimental plantations at various places and the department sustains relations with a large number of collaborators in various institutions.

THE WILLIAM H. WELCH FUND OF THE JOHNS HOPKINS MEDICAL SCHOOL

THE General Education Board, endowed by Mr. John D. Rockefeller, has appropriated $1,400,000 for the Johns Hopkins Medical School to establish an endowment to be known as the William H. Welch fund, in honor of Dr. Welch, to whom the organization and development of the school are in a large measure due. The objects of the fund are described in a statement given out by the Rev. F. T. Gates, secretary of the General Education Board, as follows:

Since the opening of the Johns Hopkins Medical School in the early nineties, it has been universally conceded that the teaching of the underlying medical sciences, namely, anatomy, physiology, pathology and pharmacology, must be placed in the hands of men devoting their entire time to teaching and research in their subjects.

As the clinical branches are more extensive and more complicated than the above-mentioned underlying sciences, the medical faculty of the Johns Hopkins University has become convinced that it is fully as important that the clinical subjects should be cultivated and taught by men freed from the distraction involved in earning their living through private practise.

The trustees of the Johns Hopkins University and the Johns Hopkins Hospital and the medical faculty of the Johns Hopkins University united in requesting of the General Education Board funds that would enable them to reorganize the departments of medicine, surgery and pediatrics so that the professors and their associates in the clinic and the laboratories should be able to devote their entire time to their work.

In making the gift the General Education Board has placed absolutely no restriction upon the freedom of these men. They will henceforth be in position to do any service that either science or humanity demands. They are free to see and treat any one, whether inside or outside the hos-

pital, but they will accept no personal fee for any such service.

It is not expected that this radical innovation in medical teaching will deprive the Johns Hopkins Medical School of such advantages as are still to be gained from the services of other men who are practitioners of medicine and surgery. In the conduct of the dispensary, in the teaching of students and in the cultivation of the specialties men simultaneously engaged in practise will to some extent continue to be utilized.

SCIENTIFIC NOTES AND NEWS

DR. ROBERT BROOME, the authority on South African paleontology, is visiting America for a year of scientific research especially upon the ancient vertebrates of the Permian period. He has accepted a temporary appointment upon the staff of the American Museum of Natural History for this purpose, and has brought with him his private collection of South African Permian reptiles.

THE Hon. Bertrand Russell, who will this year lecture at Harvard University, and Professor Etienne Boutroux, of the University of Paris, have been appointed Woodward lecturers at Yale University.

SIR WILLIAM CHRISTIE, formerly astronomer-royal, has been elected Master of the Clockmakers' Company, London.

PROFESSOR RAYMOND DODGE, of Wesleyan University, Middletown, Connecticut, is spending the current academic year in research in physiological psychology at the Nutrition Laboratory of the Carnegie Institution of Washington, Boston. A special laboratory has been equipped with an Einthoven string galvanometer and other apparatus of a similar order of precision, including much apparatus devised by Professor Dodge.

DR. F. B. SUMNER has been appointed biologist in the Scripps Institution for Biological Research of the University of California.

DR. G. F. PADDOCK has been appointed assistant in the Lick Observatory of the University of California.

DR. ORLAND E. WHITE, recently an instructor in botany at South Dakota State College and an assistant and graduate student in the laboratory of genetics, Bussey Institution of Harvard University, has accepted the appointment as plant breeder to the Brooklyn Botanic Garden.

FATHER THEODOR ANGEHRN, S.J., has been appointed director of the Haynald Observatory, Kalocsa.

DR. GIUSEPPE BASTIANELLI, Rome, is visiting the medical institutions of the United States.

PROFESSOR W. M. HAYS, former assistant secretary of agriculture, has gone to Argentina as a consulting adviser to the secretary of agriculture of that country. His services were secured with a view to the inauguration of a plan for rural education. It is expected that he will be absent from this country six months or more. Mrs. Hays accompanied him.

DR. FRANK E. LUTZ, accompanied by Mr. Charles W. Leng, has been in Cuba on an entomological collecting trip on behalf of the American Museum of Natural History. After a period of study in Havana where facilities for work were accorded by Professor Carlos de la Torre, the expedition established field headquarters in Pinar del Rio.

WITH the sanction of the British secretary of state, Sir Aurel Stein has undertaken an expedition into Central Asia, which he expects to occupy him for nearly three years. Proceeding to Chinese Turkestan by a hitherto unexplored route, he plans to spend the winter in the desert, afterwards extending his work further east towards the western borders of China.

DR. W. J. HUMPHREYS, professor of physics in the United States Weather Bureau, lectured at the University of Illinois on October 23. His subject was "The Temperature Effects of Volcanic Dust in the Atmosphere."

AT a joint meeting of the Philadelphia Section of the Illuminating Engineering Society and the Philadelphia Photographic Society held at the Engineers Club on October 17, Dr. A. W. Goodspeed read a paper entitled "A simple unit method for measuring the actinic effect of illuminants both primary and secondary." This paper embodied an analysis of

the practical photographic methods of Frank Morris Steadman.

The Gresham lecturer on astronomy, Mr. Arthur R. Hinks, F.R.S., delivered a course of four lectures on astronomy in daily use, on October 14, 15, 16 and 17, at the City of London School, Victoria Embankment. The subjects of the four lectures were: "The Determination of Time," "The Distribution of Time," "The Determination of Position" and "Measurement of the Size and Shape of the Earth."

The first ordinary meeting of the Medical Society of London for the session 1913–14 was held on October 13, when the new president, Sir David Ferrier, F.R.S., delivered his inaugural address. The Lettsomian lectures of the society will be given on February 2 and 16 and March 2 by Dr. F. M. Sandwith, who will treat of the subject of dysentery.

Dr. Philip Reese Uhler, since 1891 provost of the Peabody Institute, Baltimore, known for his contributions to entomology and geology, died on October 21, aged seventy-eight years.

William Theodore Wenzell, emeritus professor of chemistry in the California College of Pharmacy, of the University of California, died July 31, 1913.

The thirty-first annual congress of the American Ornithologists' Union will convene in New York City on November 10, at 8 P.M. The evening session will be devoted to the election of officers and the transaction of other routine business. The meetings, which are open to the public and devoted to the reading and discussion of scientific and popular papers on ornithology, will be held at the American Museum of Natural History, November 11–13, from 10 o'clock A.M. until 4 P.M. each day. Information regarding the congress can be had by addressing the secretary, Mr. John H. Sage, Portland, Conn.

The Rush Society for the correlation and support of medical and biological lectures in Philadelphia announces the following lectures, which will be held at the College of Physicians or at the Medical Laboratories of the University of Pennsylvania.

Samuel D. Gross Lecture of the Philadelphia Pathological Society, October 23, at 8:30 P.M. Professor E. G. Conklin, Princeton University, "The Mechanism of Heredity and Development."

The Fifth Rush Society Lecture, November 18, at 8:30 P.M. Frederick L. Hoffman, The Prudential Insurance Co. of America, "The Incidence of Cancer by Organs and Parts of the Body Affected."

The Mütter Lecture, December 12, at 8:30 P.M. R. C. Coffey, M.D., Portland, Oregon, "The Surgical Treatment of Chronic Constipation."

The Sixth Rush Society Lecture, January 27, at 8:30 P.M. Professor Sven G. Hedin, M.D., University of Upsala, "Colloidal Reactions and their Relations to Biology."

The Weir Mitchell Lecture, February 25, at 8:30 P.M. Harvey Cushing, M.D., Harvard University, "Clinical Types of Dyspituitarism."

The Seventh Rush Society Lecture, March 11, at 8:30 P.M. John Howland, M.D., Johns Hopkins Hospital, "A Consideration of Certain Aspects of Rachitis." (This lecture is also the annual address before the Alpha Omega Alpha Honorary Medical Society.)

The Eighth Rush Society Lecture, April 1, at 3:30 P.M. Alexis Carrel, M.D., The Rockefeller Institute for Medical Research, "Permanent Active Life of Tissues Outside of the Organism." (This lecture is also the annual address before the Undergraduate Medical Society of the University of Pennsylvania.)

Annual Address of the Philadelphia Pathological Society, April 23, at 8:30 P.M Richard P. Strong, M.D., Harvard University, "Bubonic Plague."

The fifteenth annual conference of the Association of American Universities will be held at the University of Illinois, on November 6, 7 and 8. The session of the first day will be given to a meeting of the executive committee and meetings of the conference of deans and similar officers of graduate schools. The program thus far announced for the other two days is as follows: "The Type of Graduate Scholar," by President John Grier Hibben, of Princeton University; "The Library as University Factor," two papers, one by Mr. Guy Statton Ford, University of Minnesota, and the other by Wm. D. Johnson, librarian, Columbia

University; Bureau of Education paper by Professor Kendric C. Babcock, University of Illinois.

UNIVERSITY AND EDUCATIONAL NEWS

The General Education Board, in addition to the gift of $1,400,000 to the Johns Hopkins Medical School, has made conditional appropriations of $200,000 for Barnard College, Columbia University; $200,000 for Wellesley College, and $50,000 for Ripon College.

Two gifts have been made to the Massachusetts Institute of Technology from anonymous donors, sums of half a million and one hundred thousand dollars respectively. There is an understanding that the larger gift is to be used for the buildings, while the other has no restrictions.

By the will of the late Simeon Smith, of Indiana, DePauw University has recently added $80,000 to her productive endowment. By the terms of the will, $50,000 of this amount has been set aside specifically as an endowment of the department of chemistry. Professor W. M. Blanchard, head of the department, has just returned from his sabbatical year in Europe.

A gift of ten lakhs of rupees for the promotion of scientific technical knowledge has been made by Dr. Rash Bahari Ghosh to the University of Calcutta.

Fritz Wilhelm Woll, since 1906 professor of agricultural chemistry in the University of Wisconsin, has been appointed professor of animal nutrition in the University of California.

Dr. Max Morse has become a member of the depart of physiology, division of biochemistry, of the University of Wisconsin.

The following new appointments to the faculty of the school of medicine, University of Pittsburgh, have been made this fall: Dr. W. E. Gardner, assistant demonstrator in anatomy; Dr. J. W. McMeans, assistant in clinical pathology and demonstrator in pathology; Dr. A. H. McCreery, R. B. Mellow fellow in pathology; Dr. J. C. Irwin, instructor in obstetrics; Dr. R. J. Cary, demonstrator in medicine; Dr. Arthur Miltenberger, assistant demonstrator in obstetrics; Dr. J. H. Seipel, assistant demonstrator in obstetrics; Mr. Orville J. Walker, assistant in physiology and pharmacology. The following increases in rank have likewise been provided for: Dr. Chris Gardner, from assistant demonstrator to demonstrator in anatomy; Dr. W. L. Croll, from instructor to assistant professor in obstetrics.

Dr. Orren Lloyd-Jones, formerly assistant in the department of experimental breeding of the College of Agriculture, University of Wisconsin, has gone to the Iowa Agricultural College as assistant professor of animal husbandry. He will have charge of the work in genetics in that department.

Professor Otto Wilckens, professor at Jena, has been called to the chair of geology and paleontology at Strasburg, to succeed Professor E. Holtzapfel.

Dr. Gustav Störring, of Strasburg, has been called to Bonn, to fill the chair of philosophy vacant by the removal of Professor Oswald Külpe to Munich.

DISCUSSION AND CORRESPONDENCE

ON THE OCCURRENCE OF A PROBABLE NEW MINERAL[1]

During the investigations of the carnotite and vanadium deposits of Colorado and Utah, which were carried on last winter for the United States Bureau of Mines by Professor R. B. Moore and myself, a small deposit of what is apparently a new mineral was found. This mineral was located about sixteen miles southeast of Thompsons, Utah, and later on in the workings of a drift near the rim-rocks on the north side of East Paradox Valley, Colorado. A very similar material was also found near Green River, Utah. The mineral is a black carbonaceous material which shows a high activity in the electroscope. It occurs in sandstone of Jurassic Age and is found imbedded in the carnotite. At Thompsons the ore was located at the outcrop on the surface

[1] Published by the permission of the Director of the Bureau of Mines, Washington, D. C.

of a steep wall and there was one pocket of a lenticular form containing the mineral, with a cross-section of about 8 by 10 inches. A few feet away there was an imbedded layer of the material showing at the surface for a distance of about eight feet. This layer was sloping down at an angle of about 10 degrees, measuring at the upper end about 1½ inches and thickening out toward its lower end to about 3 inches. At a deposit in the Paradox Valley, Colorado, the same mineral occurred in small pockets imbedded in and lying between the carnotite and high-grade vanadium sandstone. At Green River, Utah, there was a considerable amount of associated gypsum.

The cracks, interstices, and part of the exposed surface of the mineral are partly coated with carnotite. The carnotite can be easily removed from the black mineral by sliming the crushed carbonaceous material. The black mineral on being dried shows a high activity, somewhat higher than would be expected from the uranium content.

The mineral burns with a feeble flame and on ignition leaves a light brown ash.

As already stated, the mineral is intimately associated with carnotite, so much so that it would appear that the carnotite may be a secondary transformation product of this mineral. The structure is massive and brittle; the luster metallic, dull to shiny and submetallic; the color black; fracture uneven; specific gravity 1.972 to 1.984; hardness 3 to 3.2; and streak black to brownish black.

A typical preliminary analysis of the mineral made by C. F. Whittemore, of the Denver office of the Bureau of Mines, after the carnotite had been removed and its absence confirmed by careful examination with a microscope is as follows:

	Per Cent.
Water	7.45
Carbonaceous material	74.30
Silica	.07
V_2O_5	1.62
U_3O_8	9.43
Fe_2O_3	3.29
Al_2O_3	1.17

Several analyses appear to show that the uranium content is fairly constant, but the vanadium varies, one result being as low as 0.38 per cent. This would seem to indicate that a part, if not all, of the vanadium is in the form of roscoelite or some similar mineral which was not completely removed by the mechanical treatment.

Further work is being done on this mineral, which will be published later, and we desire to reserve priority rights for the completion of the work, and the naming of the mineral.

KARL L. KITHIL

U. S. BUREAU OF MINES

SCIENTIFIC BOOKS

School Hygiene. By FLETCHER B. DRESSLAR, Specialist in School Hygiene, United States Bureau of Education. The Macmillan Company. 1913. Pp. 369.

Educational hygiene has four leading and interrelated divisions: (1) the hygiene of physical and mental growth; (2) health and medical supervision of schools; (3) the hygiene of instruction, and (4) the hygiene of the school plant.

Dr. Dresslar's book deals mainly with the last division. Of the twenty-six chapters, eighteen deal chiefly with the school plant, eight with problems relating to the hygiene of growth, two with the hygiene of instruction, and one with medical inspection.

According to the preface, "It is the purpose of this book to set forth in a simple and untechnical way some of the hygienic requirements of school life, and to suggest, whenever it seems necessary, how these requirements may be put into practise. No attempt has been made to treat any phase of the subject exhaustively. The purpose has been to select the most important topics, and to deal with them in a manner as simple as is consistent with the truth. It has not been written for the specialists in school hygiene, but for busy teachers."

The volume is a much-needed and extremely valuable addition to our literature on school hygiene. The author's extensive first-hand acquaintance with the problems of schoolhouse construction and equipment adds very greatly

to the practical value of the book. Such topics as location and construction of school buildings, schoolhouse lighting, school desks, school baths, water supply, drinking fountains, toilet arrangements, ventilation, heating, schoolroom cleaning, janitor service, disinfectants, etc., have here the best treatment that they have received in any English text. In general, the book presents just those facts about school buildings which every person needs to know who has anything to do with their construction or care, and it is certain to become an indispensable handbook for school officers of every class.

It would be unfair to criticize the author for the brevity with which he treats the problems relating to the hygiene of growth, school medical inspection and the hygiene of instruction. The field of school hygiene has become too broad to permit adequate treatment of all the above-named divisions in a single volume. The division chosen for treatment in this book is one on which America had produced no first-class text in more than a decade, and the author has done his work well. The chapters on location and construction of school buildings, schoolhouse lighting, school desks, heating and janitor service are especially valuable.

Here and there the critical reader will find statements with which he may be inclined to disagree. Many will probably think the author's position on some of the problems of ventilation somewhat conservative, particularly in the scant consideration which is given to the experiments by Leonard Hill and others on the relative effects of humidity, temperature, movements and chemical composition of the air on physical efficiency. In all of these newer experiments the author declines to see anything revolutionary as regards the practical problems of ventilation, and the three main references cited on this chapter bear the dates 1893, 1896 and 1897, respectively.

Among the statements open to question are the following: "The results of careful examinations made in all progressive countries prove conclusively that the school conditions are responsible for a large part of the near-sightedness prevalent among children of the higher school grades"; "myopia is not often, if ever, inherited," etc. (p. 221). Kotelmann is quoted approvingly to the effect that myopia is never found among primitive races. In regard to stuttering, the author states that "many, perhaps most, cases find an immediate cause in imitation" (p. 265). In speaking of the rapid progress made by Filipino school children in learning a foreign language the author states (p. 296) that it would be "utterly impossible to make the same progress with ignorant adults." That myopia is school-caused and never hereditary, that stuttering usually results from imitation, that children have greater learning capacity than adults are views which tradition has long sanctioned, but which recent investigations have thrown much doubt upon.

Certain other passages are, perhaps, open to question in the same way, and objection might be taken in a few cases to the author's selection of references. But to dwell on such minor points of criticism would be unfair, so carefully has the work in general been performed. The treatment is authoritative and comprehensive, yet the style is easy, stimulating and interesting. The book will long remain a standard treatise, especially on the construction and equipment of school buildings.

LEWIS M. TERMAN

The Geology of Soils and Substrata with Special Reference to Agriculture, Estates and Sanitation. By HORACE B. WOODWARD, F.R.S. London, Edward Arnold; New York, Longmans, Green & Co. 1913.

The intent of the writer of this work, as noted in his preface, is "to provide such information relating to the land surface as will be useful to students and teachers of agriculture, to those occupied in the management of estates and farms, or in sanitary engineering works." To do all this within a small octavo volume of but 366 pages is no small task and one that would be well-nigh if not quite impossible for any but a restricted area such as is comprised within the limits of Great Britain.

The author begins with a brief account of the aims and purposes of geology and the preparation of geological maps and soil surveys. He then passes to a discussion of the soils, their origin and fertility; the climatic conditions affecting them; their mineral and chemical composition and physical characteristics; drainage and irrigation; mineral fertilizers; forests and woodlands and the associated geological features; orchards, gardens and vineyards; geological considerations concerning estates; mineral rights; house sites with reference to drainage and water supply; closing with a series of eleven chapters on the geological formations of the various ages as occurring in England, with especial reference to the subjects previously treated. It is remarked that a map of the surface soil alone gives but a very imperfect idea of the capabilities of the land. Further, that no actual map showing the distribution in detail of the surface soils over any extended area has as yet been published, the so-called soil maps of the United States and Germany being in reality subsoil maps with indications of the nature and depth of the soil at particular spots. A good subsoil map, showing the variations in the strata, "whether drifts or the more regularly stratified formations, will always indicate the general distribution of the surface soils."

The most original portion of the book is that contained in the closing eleven chapters, in which all the principal geological formations of the kingdom are considered with reference to their soils, mineral resources, drainage and general availability for economic purposes. In this respect the work is quite unique, and, though local in its application, contains matter of value to the general reader. Illustrations are numerous, although, as is customary in works from the English press, line sketches preponderate over the half-tone reproductions from photographs, such as are so pronounced a feature of American works.

Mr. Woodward, it will be recalled, is also the author of the "History of the Geological Society of London," and "The Geology of Water Supply."

George P. Merrill

NOTES ON METEOROLOGY AND CLIMATOLOGY

EUROPEAN METEOROLOGY

European meteorologists have recently given much attention to aeronautical, dynamical and mountain meteorology and to atmospheric electricity. In aeronautical meteorology greatest attention is being given to wind structure and to detailed forecasts for aviators. Research in dynamical meteorology is now particularly directed towards finding the laws governing the connection between upper-air processes and the weather at the earth's surface, with a view toward increased accuracy and range of weather forecasts.

An important institution for the study of dynamic meteorology is the set of synoptic charts of the atmospheric conditions over Europe, prepared under the direction of Professor V. Bjerknes, of Leipzig, from the monthly international aerological observations. Professor Bjerknes is the author of the still unfinished great work on "Dynamic Meteorology and Hydrography" which is being prepared under the auspices of the Carnegie Institution of Washington. The volumes on statics and kinematics have already appeared; and two more on dynamics and thermodynamics are yet to come.

In mountain meteorology, the föhn, local whirls and the difference in temperature between mountains and the free air at equal elevations have recently been studied.

Concerning atmospheric electricity, Mr. F. Schindelhauer in a thorough work entitled, "Über die Electrizität der Niederschläge,"[1] has discussed the results of the registration of the electricity of precipitation at Potsdam, 1909 to 1911. The electricity of precipitation is thought to be from the splitting up of large drops (Lenard waterfall effect), from the influence of the charge of the air, or the result of friction with the electrified air (dirigible balloons are sometimes ignited from electricity thus generated). Dr. K. Kähler in an article entitled "Der Einfluss des Wetters auf die

[1] *Veröffentlichungen des Kön. Preussischen Met. Inst.*, 1913, No. 263.

Atmosphärische Electricität,"[2] has pointed out that although weather affects atmospheric electricity the effects of the latter on the former are unknown. Mr. Carl Störmer's expedition to Bossekop, February 28 to April 1, 1913, secured 636 pairs of simultaneous photographs of the aurora from points 27 kilometers apart, most of which are very satisfactory for computing with a large degree of accuracy the form, position and altitude of all the principal kinds of aurora. Prismatic and kinematic photographs were also taken. The full results will be published in considerable detail later.[3]

SOUTHERN HEMISPHERE SEASONAL CORRELATIONS

A CONTINUED article on this subject by Mr. R. C. Mossman, of the Argentine Meteorological Office, is now appearing in *Symons's Meteorological Magazine.*[4] Abnormal conditions in one "center of action"[5] are accompanied by abnormal weather in others, and often indicate future conditions at distant points—a fact now used successfully in seasonal forecasts in India. A pronounced feature of many correlations is their temporary character, this applying more particularly to pairs of stations not located in action centers. For instance, from 1876 to 1894 an excess of rainfall at Trinidad from April to September was generally followed by a deficiency in rainfall during the next six months at Azo, Argentine Republic. Little correlation is shown before or after the above period. Java rainfall from October to March, 1880 to 1909, was generally the reverse of Trinidad rainfall for the following six months. Thus an excess of rainfall at Java for the months October to March gave indication of an excess to follow at Azo one year later.

[2] *Das Wetter*, Berlin, 1913, pp. 49–56, 128–133, 173–178.

[3] From *Nature*, London, 1913, Vol. 91, pp. 584–585 (with reproductions of some of the photographs). Also Meteorologische Zeitschrift, 1913, pp. 410–412.

[4] Vol. 48, pp. 2–6, 44–47, 82–85, 104–106, 119–124.

[5] By "center of action" is meant one of the more or less permanent cyclones or anticyclones in control of the atmospheric circulation over a large area—*e. g.*, the Iceland cyclone, the Azores anticyclone.

CHANGES OF CLIMATE IN THE SOUTHWEST

SUCH changes during historical time as indicated by tree rings and "climatic terraces" have recently received the attention of Messrs. A. E. Douglass[6] and Ellsworth Huntington.[7] Mr. Douglass found by a test extending over forty-three years that the radial thickness of the rings of the yellow pine of northern Arizona gives a measure of the rainfall in that region with an average accuracy of over 70 per cent. Through examination of the rings of 100 trees, of which five were measured to the number of 400 rings and two to 500, a 21-year and a 11.4-year variation, each amounting to 16 per cent. of the mean were found. Its plot derived from 492 years shows two maxima which correspond in time with two maxima of rainfall in the 50 years of records on the south California coast. These in turn match with the major and minor maxima in the temperature of that region for the same period. The larger maximum of the latter occurs at the time of the sun-spot minimum as averaged for 125 years. Mr. Huntington supports these and his own results from studies of tree rings with evidences from alluvial terraces (5 to 1,000 feet high) of the rather dry mountainous regions of the southwest. These terraces are ascribed to variations in stream erosion or lake level due to variations in rainfall. Mr. Huntington has discussed this subject fully in previous works ("Explorations in Turkestan" and "The Pulse of Asia") and intends soon to discuss it with regard to America.

[6] "Pine Trees as Recorders of Variations in Rainfall," Astron. and Astrophys. Soc. of America. Abstract in *Bull. Int. Inst. of Agric.* and in *Quarterly Journal of the Royal Meteorological Society*, 1913, pp. 244–245.

[7] "The Shifting of the Climatic Zones as Illustrated in Mexico," *Bull. Am. Geogr. Soc.*, 1913, pp. 1–12; *Geogr. Journ.*, June, 1913; *Quarterly Journ. of the Roy. Met. Soc.*, 1913, pp. 245–246. "Secret of the Big Trees, Yosemite, Sequoia and General Grant National Parks," Pub. U. S. Dept. of the Interior, 1913, 24 pp., 14 figs.

CORONIUM

The discovery of the new gas "coronium" in the solar atmosphere from observations taken during the total solar eclipse of April 17, 1912, as announced in the London *Daily Citizen*, August 5, 1913, marks a turning point in the search for this long-suspected gas. The periodic law of chemical elements, enunciated by Mendeléeff more than forty years ago, calls for this gas, giving it an atomic weight much less than that of hydrogen. From a study of the spectra of meteors and the aurora Dr. A. Wegener[8] has attempted to prove the existence of this gas (which he calls "geocoronium") in the earth's atmosphere. He concluded that at a height of about 70 kilometers, this gas becomes an appreciable percentage of the atmosphere; that it increases to equality with hydrogen at about 200 kilometers, and eventually becomes practically 100 per cent. at 400 or 500 kilometers altitude.[9] Beyond this he considers interplanetary and interstellar space filled with this light-transmitting gas, inconceivably thin, but thickening locally around the planets, stars and sun (solar corona). The actual chemical determination of the presence of this gas in our atmosphere will be difficult, for at sea-level it is present (hypothetically, after Wegener) in but 0.00058 volume per cent.

EXPLORATION OF THE INTERIOR OF GREENLAND

Captain Koch and his three companions, who have just returned to Denmark from Greenland, were the first to accomplish the difficult feat of traversing Greenland at its widest part (lat. 72°). The head-blizzards first encountered and later the dazzling sunlight of the interior plateau correspond closely with the meteorological conditions encountered on the rather similar antarctic continent. Greenland was first crossed in 1888 by Nansen at latitude 64°; Captain Peary crossed the northwestern end three times, 1892–1895, and A. de Quervain crossed at latitude 68° in 1912. Long trips into the interior from the west coast were made in 1883 by Baron Nordenskiöld at 68°, and in 1886 by Captain Peary at 69°.

EARTHQUAKES AND RAINFALL

Although Ferdinand de Montessus de Ballore after a study of the rainfall conditions preceding 4,136 earthquakes, was unable to find any connection, Professor Omori has found an apparent relationship between the annual frequency of earthquakes at Tokyo and the amount of rainfall in northwestern Japan. The periods when earthquakes were infrequent but severe correspond in a striking manner with those when rainfall was deficient at Niigata and Akita on the Japan seacoast, while in years of maximum earthquake frequency at Tokyo, the amount of rain and snow falling in the north was much above the average.[10]

NOTES

The great heat in the middle west this summer broke all previous records for that section, both in duration and degree. For instance, the temperature at St. Joseph, Mo., from June 14 until September 9 exceeded 90 degrees on all but fifteen days; on twenty-six days it exceeded 100 degrees and on ten days reached 104. The injurious effect of this heat spell was greatly accentuated by the general drought prevailing throughout the period.

Daily wireless weather reports are being received at Melbourne from Dr. Mawson, in charge of the Australian Antarctic Expedition now exploring the coast of Antarctica.

Prince Galitzine on July 18 became director of the Nicholas Central Physical Observatory, St. Petersburg, succeeding General M. Rykatchew, who retired.

Dr. H. Mohn, director of the Meteorological Institute of Norway since its foundation in 1866, and professor of meteorology in the Uni-

[8] "Untersuchungen über die Nature der obersten Atmosphärenschichten," *Physikalische Zeitschrift*, Leipzig, 1911, pp. 170–178, 214–222.

[9] Cf. W. J. Humphreys, "Distribution of the Gases in the Atmosphere," *Bull. Mt. Weather Obs.*, 1909, II., 2.

[10] *Nature*, London, Vol. 91, p. 65.

versity of Christiania, has retired. Mr. Askel S. Steen succeeds him in these capacities.

CHARLES F. BROOKS

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SPECIAL ARTICLES

RELIABILITY AND DISTRIBUTION OF GRADES

If we consider grades scientifically as a scale of measurements, two important questions arise: (1) How fine a scale of units is distinguishable, and (2) What proportion of persons will ordinarily fall under each unit?

First, let us examine the question as to the size of distinguishable steps. The answer to this question can be determined by the reliability with which marks can be assigned. Recent studies have revealed an exceedingly wide divergence in the grades assigned by different teachers to the same papers. Starch and Elliott[1] found that the grades assigned to two English papers by 142 teachers of English ranged in the case of one paper from 64 to 98 with a probable error of 4.0, and in the case of the other paper from 50 to 98, with a probable error of 4.8. This wide range is not due to the fact that these were language papers, since the grades of a mathematics paper assigned by 118 teachers of mathematics ranged from 28 to 92, with a probable error of 7.5 points.[2]

What bearing do these facts have upon the reliability of marks and how are we to explain such wide ranges of differences? Four major factors enter into the problem which, I believe, fully account for the situation: (1) Differences among the standards of different schools, (2) Differences among the standards of different teachers, (3) Differences in the relative values placed by different teachers upon various elements in a paper, and (4) Differences due to the pure inability to distinguish between closely allied degrees of merit.

How much of the variation is due to each factor? To determine the strength of the first factor we must find out the range of variation in the grades assigned by teachers in the same institution and departments instead of different institutions. To this end I obtained ten papers written in the final examination in freshman English at the University of Wisconsin, and had them graded independently by ten instructors of the various sections of freshman English. An effort is made by cooperation among the instructors concerned to have as much uniformity as possible in the conduct of these sections. The same final examination is given to all.

Table I. gives the marks assigned by each instructor to each paper. The first column contains the grades assigned by the teachers under whom the students took the course. Papers 6 and 10 were obtained from the class of one instructor and all the other papers from the class of another instructor. These ten

TABLE I

Papers	Instructors										Average	Mean Var.	Coefficient of Variability
	1	2	3	4	5	6	7	8	9	10			
1	85	86	88	85	75	80	88	87	85	87	84.6	2.8	.034
2	77	80	87	80	62	82	82	87	85	87	80.0	4.6	.057
3	74	78	78	75	69	84	91	83	79	80	79.1	4.4	.056
4	65	65	62	20	26	60	55	68	55	50	52.6	12.3	.233
5	68	82	78	82	64	88	85	86	78	80	79.1	5.7	.070
6	94	87	93	87	83	77	89	88	88	89	87.5	3.2	.036
7	88	90	95	87	79	85	96	91	87	89	88.7	2.6	.029
8	80	84	73	79	72	83	85	91	77	76	80.0	4.6	.058
9	70	70	68	50	44	65	75	81	79	79	68.1	9.1	.118
10	93	92	85	92	81	83	92	89	84	85	87.6	4.0	.045
Av.	79.4	81.4	79.8	73.7	65.5	78.7	83.8	85.1	79.7	80.2		5.3	.074

General average 78.7.

[1] D. Starch and E. C. Elliott, *School Review*, 20: 442–457.

[2] D. Starch and E. C. Elliott, *School Review*, 21: 254–259.

papers were graded after each instructor had graded the papers from his own sections.

(1) The table reveals an exceedingly wide range of marks, a range just as large as that of the English and mathematics papers referred to above. The average of the mean variations is 5.3 as compared with an average of 5.4 of the English and mathematics papers. (2) The mean variations are fairly uniform for all papers except 4 and 9. These two, no doubt, vary so much more widely than the others because both have an average below the passing grade. Judgments of such papers are more apt to be haphazard since, from the practical point of view, it makes no difference what the grade is, so long as the paper is considered a failure. But the matter is quite serious in case of a paper like number 9 which is considered above passing by six and below passing by four instructors. (3) A third point of interest is the fact that the teachers under whom the students took the course grades in column 1, did not succeed in grading the papers any more accurately than the other instructors who did not know the students at all. The mean variation of the grades in column 1 from the average of each paper is practically as large, 4.7, as the mean variation of all together, 5.3. (4) There is a very noticeable difference in the standard of grading. Two instructors, 4 and 5, graded on the whole very much lower than the average and Nos. 7 and 8 graded higher than the average. These deviations can be found readily by comparing each instructor's average with the general average.

In order to eliminate the variation in the marks due to this difference in standards among the instructors, all the marks in Table I. were weighted by the amount that each instructor's average differed from the general average. The weighted values thus obtained are presented in Table II. The decimals were dropped in the transposition.

The differences in Table II. therefore represent the differences in the relative evaluation of the papers themselves irrespective of whether an instructor marks severely or leniently. It will be noticed that the mean variation is smaller, though not as much smaller as one might anticipate, being 4.3 as compared with 5.3 in Table I.

TABLE II

Papers	Instructors										Ave.	Mean Var.
	1	2	3	4	5	6	7	8	9	10		
1	85	84	87	90	89	80	83	81	86	86	85.1	2.5
2	77	78	77	85	76	82	77	81	86	86	80.5	3.5
3	74	76	77	80	83	84	86	85	80	79	80.4	3.3
4	65	63	61	25	40	60	50	49	56	49	51.8	9.2
5	68	80	77	87	78	88	80	79	79	79	79.5	2.9
6	94	85	92	92	97	77	84	83	89	88	88.1	4.7
7	88	88	94	92	93	85	81	85	88	88	89.2	2.6
8	80	82	72	84	86	83	80	85	78	75	80.5	3.5
9	70	68	67	55	58	65	70	75	80	78	68.5	6.0
10	93	90	84	97	95	83	87	83	85	84	88.1	4.5
Av.												4.3

The next step is to separate the third and fourth factors, *i. e.*, how much of the variation is due to the inability to distinguish between closely allied degrees of merit, and how much is due to differences in relative value placed by different instructors upon various aspects of a given paper, such as form, neatness, clearness, etc.

The accuracy of the ability to distinguish between various shades of merit may be ascertained by having the same person give two or more evaluations of the same papers separated by sufficiently long intervals of time, so that the details and identity of the papers have been forgotten. I have tested this point by determining how closely an instructor is able to agree with his own grades. Table III. gives pairs of grades assigned at different intervals to the same papers by the same instructor. In each case the papers were from the instructors' own classes. The aim was to have ten papers re-graded, but in some instances not that many were available.

Table III. shows that the difference in the marks assigned to the same papers by the same instructor is on the average 4.4 points, or in terms of mean variation 2.2 points. This difference is as large in one sort of papers as in another. It is as large in mathematics as in language or in science. This was to be ex-

pected in view of the fact stated at the beginning that mathematical grades are no more accurate than any other grades. The marks of the second mathematics instructor are so close, not because it was mathematics that he was grading, but because this instructor had a purely mechanical method of grading, of deducting so many points for each kind of error. weighting the second set of marks by the difference between the averages of the two markings. Without giving these weighted values in a separate table it will be sufficient to say that the average difference thus computed is 3.5 as compared with the average difference of 4.4 in Table III., or in terms of mean variation, 1.75 and 2.2, respectively.

TABLE III

Advanced Psychology, Interval 2 Yrs.			Elem. Psychology, Interval 2 Weeks			Math, Interval 9 Mos.			Math., Interval 9 Mos.			English, Interval 6 Mos.			German, Interval 6 Mos.			Elem. Psychology, Interval 4 Yrs.		
1st	2d	Dif.	1st	2d	Dif.	1st	2d	Dif.	1st	2d	Dif.	1st	2d	Dif.	1st	2d	Dif.	1st	2d	Dif.
85	87	2	85	79	6	36	51	15	56	60	4	70	75	5	79	70	9	70	80	10
76	80	4	87	83	4	61	67	6	70	73	3	80	86	6	90	77	13	93	91	2
83	80	3	90	93	3				77	75	2	88	88	0	77.5	73	4.5	82	84	2
89	90	1	90	92	2	61	67	6	88	90	2	74	76	2	85	81	4	75	82	7
84	83	1	83	88	5	73	79	6	62	62	0	77	76	1	78	80	2	75	86	11
93	88	5	78	79	1	81	86	5	89	87	2	85	86	1	70	61	9	78	81	3
84	75	9	93	89	4	71	63	8	82	80	2	65	65	0	72.5	58	14.5	88	90	2
93	88	5	88	88	0	71	79	8	53	56	3	68	75	7	91	86	5	83	78	5
89	85	4	78	76	2	96	87	9	75	75	0				62.5	60	2.5	93	93	0
92	86	6	83	80	3	83	90	7	67	64	3				66	65	1	83	87	4
Av. 86.8	84.2	4	85.5	84.7	3	70.3	74.3	7.8	71.9	72.2	2.1	76.0	78.4	2.8	77.1	71.1	6.5	82.0	85.2	4.6

Average of all the differences 4.4 points.

But this does not mean that his grades were more accurate or just. Another instructor might with perfect justice deduct either more or less for the same kind of error. All that it means is that this instructor was able by means of his mechanical method to match his own marks fairly closely. Furthermore, we must not infer that the other instructors had graded their papers carelessly either the first or the second time, or both times. As a matter of fact, each question had been graded in both markings of all papers except the second and third group of psychology papers and the English papers. And these are not essentially different from the rest. The results, while obtained from only seven instructors (more were not available for the purpose) are quite representative and reliable as any one familiar with statistical methods can determine from the above data. Results from twice or three times as many persons would not be materially different.

We may eliminate one further factor from Table III., namely, the difference due to a change in an instructor's standard after an interval of time. This may be eliminated by

Of the four factors stated at the outset, each contributes the following amount to the total variation: The general mean variation or probable error of grades assigned by teachers in different schools is 5.4 points. The mean variation of grades assigned by teachers in the same department and institution is 5.3. The mean variation of the latter, after eliminating the effect of high or low personal standards, is 4.3. The mean variation of grades assigned at different times by the same teachers to their own papers is 2.2. Hence the largest factors are the second, third and fourth. The fourth contributes 2.2 points, the third 2.1 points, the second 1.0 point and the first practically nothing toward the total of 5.4 points of mean variation.

Now what do all these results mean? How small divisions on our scale are practically usable? As a question of psychological methodology the units of any scale of measurements, if a single measurement with the scale is to have objective validity, should be of such a size that three fourths of all the measurements of the same quantity shall fall within the limits of one division of the scale. For

example, if the marks assigned by 75 out of 100 teachers to a given paper lie between 80 and 90, then the unit of our scale should be ten points. Any smaller division would have little or no objective significance. Of course, almost indefinitely small differences in merit can be measured if an indefinite number of independent estimates is made.

Now what are the actual facts with regard to the size of distinguishable steps in the marking scale? We have seen above that the mean variation of the estimates of a teacher in matching his own marks, after eliminating his own change in standard, is 1.75 points. According to our principle that if a unit is to be large enough in range to include three fourths of all his estimates of the same quantity, then the smallest distinguishable step that can be used with reasonable validity is $2\frac{3}{4}$ times the mean variation (1.75) or probable error, which would be 4.8, or roughly 5 points.[3]

Hence our marking scale, instead of being 100, 99, 98, 97, 96, 95, etc., should be 100, 95, 90, 85, 80, etc. These are the smallest divisions that can be used with reasonable confidence by a teacher in grading his own pupils. This means that on a scale of passing grades of 70 to 100 only seven division points are distinguishable. This substantially confirms the scheme followed in many institutions that the marking scale should be $A+$, $A-$, $B+$, $B-$, $C+$, $C-$, $D+$, $D-$ and failure. No medium A, B, C or D may be used. Letters or symbols are perhaps preferable to such designations as Excellent, Good, Fair and Poor because of the moral implication in the latter.

Even as fine a scale as this might perhaps better be replaced by a coarser one computed on the mean variation of 4.3 points, which is the mean variation of different teachers in the same department and institution after the effect of the personal standard has been eliminated. See Table II. On this basis the range of a division on the scale should be 4.3 times $2\frac{3}{4}$ or approximately 12 points. The reason for this larger step would be that this is as closely as different competent teachers agree on the evaluation of the same papers. One teacher may be as much in the right for grading a paper 80 as another for grading it 90. The only ultimate criterion is the consensus or average of estimates. This coarser scale would allow for only three divisions of passable grades, A, B and C. But the finer scale proposed above can be used with reasonable accuracy by a teacher in grading his own pupils in the light of his own viewpoint.

Of course, any one may use as fine a scale as he pleases provided one recognizes the range of the probable error of the scale used. The fine scale, if conscientiously used, probably tends to stimulate the making of finer distinctions than a coarse scale does. However, the chief objections to a very fine scale are: (1) An illusion of accuracy, (2) injustice to the student of supposed differences where there is no appreciable difference or where the relative merit might be just reversed, (3) embarrassment to the teacher due to this injustice.

If we admit the soundness of our reasoning it may seem to many teachers that even the finer scale of five point steps is rather crude and that the evaluation of a pupil's attainment is very coarse. But not so. As a matter of fact, the steps of the proposed scale are very fine and the measurement of achievement would be fairly accurate.

Apropos of this point we may compare the accuracy of making measurements of a similar type in an entirely different field. A mechanic through constant use has acquired a fairly definite mental image of an inch or a foot. Yet a mechanic's estimate of the length of a rod is not an iota more accurate than a teacher's estimate of an examination paper. I tested this problem by having eleven experienced carpenters estimate in inches as closely as they could the length of five rods varying

[3] To those who may be interested in the basis of this computation I may say that a range twice the size of the probable error includes one half of the series of estimates, and a range $2\frac{3}{4}$ times the mean variation or 3 times the probable error includes approximately three fourths of the series of estimates. In practise the mean variation and the probable error are used interchangeably, but the former is usually a trifle larger than the latter.

in length from ten inches to twenty-three inches. These "measurements" based on visual impressions are given in Table IV.

The validity of these measurements can be readily compared with the validity of the grades in Table I. by means of the coefficient of variability which is computed by dividing the mean variation by the average. The average coefficient of variability of the grades (last column in Table I.) is almost identical with that of the rods, .07 and .06, respectively. Hence measurements made by means of a mental scale are subject to the same amount of inaccuracy in one field as in another. It simply means that the mind can not discriminate any more accurately. If we are attempting to evaluate a paper by a scale of 100, 99, 98, 97, 96, 95, etc., we are attempting the impossible. The mind simply can not discriminate between a paper of grade 85 and another one of grade 86. If the second is appreciably better it more likely ought to have a grade of 90. The situation is analogous to asking a person to estimate the width of a room in inches when you should ask him to estimate it in yards. Estimates in terms of large units, of course, do not have greater absolute accuracy, but they are more apt to be uniform.

TABLE IV

Length of Rods	Carpenters											Av.	Mean Variation	Coefficient of Variability
	1	2	3	4	5	6	7	8	9	10	11			
10	11	10	10	10	8	9	9	9	8.5	9	8.5	9.1	.66	.07
15	14	14	12	13.5	12.5	14	13	14	13	13	14	13.4	.6	.05
17	17	16	15	14	14	16	15	15	17.5	15	17	15.6	1.1	.07
20	20	21	18	22	18	20	19	17.5	20	18	19	19.3	1.2	.06
23	24	24	21	21	20	22	21	22	24.5	24	22	22.3	1.3	.06
Av.														.062

Several criticisms have been suggested to me in discussing the results presented in this paper. For example, some teachers state that they do not attach much importance to the final examination, but grade the student largely by his other work, such as themes, daily recitations, etc., and that the situation is very different in those matters. This objection is beside the point because you are simply shifting the responsibility to something else. You are simply using the same scale for measuring something of similar nature.

Then it has been suggested that the grades in Table I. must necessarily be inaccurate because these instructors did not know the students who wrote the papers. But just on that account they would be all the more able to give an unprejudiced evaluation of the papers as papers. Many teachers have the practise of placing the papers so that when they pick one up for grading they do not know whose paper it is. If then the teacher wishes to raise or lower the mark according to the diligence or negligence of the student, well and good, but that does not mean that the grade of the paper will be any more accurate.

A third suggestion is that with a fine scale of marking the teacher is able to impose a penalty for shiftless work and indifferent attitude. But with a coarser scale on which the steps really mean something it is possible to attach a penalty of real significance.

The second part of this paper relates to the distribution of grades. How frequently should each division of the scale be used when assigning marks to large groups of pupils? By various psychological reasons, which I shall not state here,[4] it can be shown that the distribution of grades among large groups of students who have not been subject to special selection, should follow the probability curve. Thus the distribution of marks of college freshmen, who, strictly speaking, are a more or less select group, should, and in fact does, conform to the probability curve. Fig. 1

[4] See Dearborn, W. F., "School and University Grades," *Bulletin of the University of Wisconsin*, No. 368.

shows how closely the two agree. The curve representing the distribution of marks is based on approximately 5,000 grades assigned to freshmen in the college of letters and science in the University of Wisconsin.[5]

Theoretically, then, on the basis of the probability curve, 3 per cent. of the students should receive *A* + (97–100), 7 per cent. *A* — (93–96), 16 per cent. *B* + (89–92), 23 per cent. *B* — (85–88), 23 per cent. *C* + (81–84), 16 per cent. *C* —(77–80), 5 per cent. *D* + (73–76), 3 per cent. *D* — (70–72) and 4 per cent. failure. The percentage of failures is largely arbitrary and should perhaps be higher than here indicated.

The problem of distribution, however, is more complex in the upper classes after considerable elimination has occurred during the freshman and sophomore years. Two extreme positions have been held. Professor Meyer[6] holds that the nature of the distribution in upper classes is the same in spite of the elimination, that although the curve becomes contracted at the base it remains the same in shape. President Foster,[7] on the other hand, holds that the curve should have a very abrupt drop from the middle toward the lower end, on the belief that the university rigorously selects only those in the upper half of the curve. Neither position is entirely justifiable, for the reason that there is elimination during the freshman and sophomore years largely on the basis of intellectual fitness, and that this elimination is not exclusively from the lower half or from the lowest quarter, but is distributed over a large portion of the curve. The only way to determine the form of the curve is by finding the actual facts in the case. That is, in what part of the curve does the elimination occur, and how many are eliminated at each point?

I have computed this on the basis of the curve in Fig. 1 by taking the group of students there represented and finding out which ones dropped out and what their average grades were. Fig. 2 starts with the probabil-

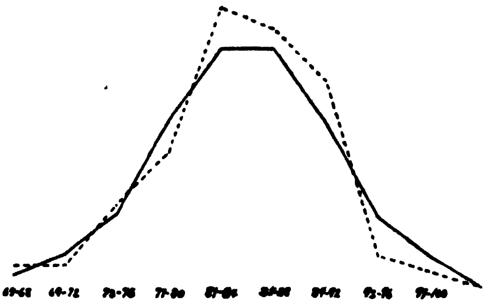


FIG. 1

ity curve and shows what the shape of it is after the elimination in the first two years. The curve shows that elimination is greatest at the lower extreme and gradually becomes less up to the grade of 93, above which there is almost no elimination.

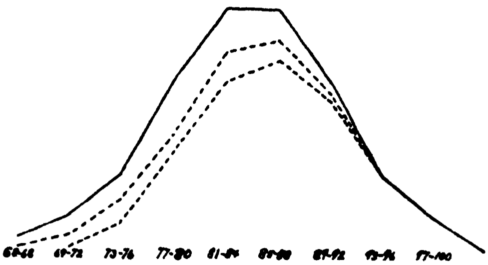


FIG. 2

Theoretically, on the basis of this modified curve, the distribution of grades in the upper two years should be as follows: 4 per cent. of the students should receive *A* +, 10 per cent. *A* —, 20 per cent. *B* +, 24 per cent. *B* —, 22

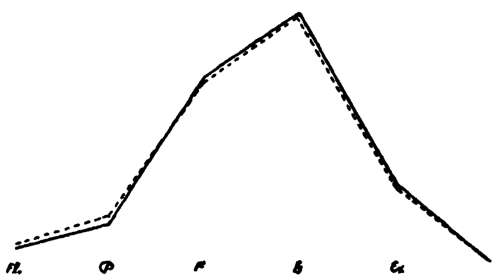


FIG. 3

[5] Dearborn, W. F., "The Relative Standing of Pupils in the High School and in the University," *Bulletin of the University of Wisconsin,* No. 312, plate I.

[6] Meyer, M., SCIENCE, N. S., 28: 246–250.

[7] Foster, W. T., SCIENCE, N. S., 35: 887–889.

per cent. $C+$, 11 per cent. $C-$, 4 per cent. $D+$, 2.5 per cent. $D-$ and 2.5 per cent. failure; or using only the four large steps, 14 per cent. should receive A, 44 per cent. B, 33 per cent. C, 6.5 per cent. D and 2.5 per cent. failure.

Fig. 3 shows how closely the actual distribution of the grades of upper classmen coincides with the theoretical distribution here computed. The continuous line is the theoretical distribution and the broken line is the actual distribution of 5,404 grades assigned to upper classmen in the college of letters and science in the University of Wisconsin. The latter are taken by permission from the unpublished report of Dean Birge.

The adoption of a uniform scale of grades as well as a uniform standard in the frequency with which the different grades are assigned is a pressing need among colleges and secondary schools. These ends could be attained by adopting the scale of eight passing grades, or the coarser one, for reasons given in the earlier part of this paper, and by having each teacher and each institution compare the frequency of the various grades assigned with the theoretical frequency. Then an $A+$ or a $B-$ would have more nearly the same significance under different teachers and in different institutions than they have at the present time.

DANIEL STARCH
UNIVERSITY OF WISCONSIN

THE AMERICAN CHEMICAL SOCIETY

ROCHESTER MEETING

THE forty-eighth annual meeting of the American Chemical Society was held at Rochester, New York, September 8 to 12. This is the first meeting held in September under the newly adopted constitution, and the large number present and the enthusiasm of the meeting amply justify the change in date from the Christmas holidays to the fall of the year.

Below will be found titles of the papers given at the meeting, with such abstracts as could be obtained. A study of the list shows a number of valuable contributions in both theoretical and applied chemistry. Most of these papers will be published in full in the journals of the society.

A complimentary dinner was given by the Rochester Section to the council on the evening of September 8, and following this dinner was held the annual council meeting of the society. Charles L. Parsons was elected secretary of the society, and Dr. A. P. Hallock, treasurer, for a period of three years, under the revised constitution. W. A. Noyes was elected editor of the *Journal of the American Chemical Society*, and the board of associate editors was continued, with the exception of H. P. Talbot and A. A. Noyes, who asked to be relieved of this duty. W. Lash Miller, of the University of Toronto, was elected to the board with special reference to physical chemistry. M. C. Whitaker was elected editor of the *Journal of Industrial and Engineering Chemistry*, and the board of associate editors was continued and the editorial staff strengthened by the addition of two assistant editors. A. M. Patterson was reelected editor of *Chemical Abstracts*, and J. J. Miller and E. J. Crane associate editors.

The first general session was held in the assembly hall of the Eastman Kodak Company, Kodak Park, on Tuesday morning, and was opened by a cordial address of welcome by Mayor Edgerton, and replied to by President Little. Papers were presented as indicated below.

At the conclusion of the morning session the members and their guests were entertained at luncheon by the Eastman Kodak Company. After luncheon the manufacturing department of the Kodak Company was inspected by the members present, who were divided into groups of fourteen for the purpose and placed under the guidance of members of the Eastman Company's technical staff. This opportunity to see one of the most highly developed chemical industries in America was thoroughly appreciated. On Tuesday evening, the members were entertained by the Rochester Section at a smoker, the program for which had been prepared under the able direction of M. H. Eisenhart, assisted by other members of the local section, who provided an extensive program and elaborate feast for the occasion. Each guest was decked out in a commodious white apron, on which was inscribed in bold letters his name and address, and also wore a yellow Chinese mandarin cap with pigtail. The hall was decorated with flags, and contained many small balloons filled with hydrogen, which, as their buoyancy diminished, afforded special opportunities for amusement of the guests. Unusually attractive songbooks had been printed in the works of the Kodak Company, bearing the pin of the society in colors. Three other attractive souvenirs were distributed to each guest.

The smoker program was arranged with great care and consisted of solos by both local and professional talent, interspersed with music from an orchestra, songs from a membership quartette, interesting and instructive moving pictures, and several impromptu parades by guests. The entire function was most thoroughly organized and executed and will stand as a monument to the skill of the Rochester Section. On Wednesday night, President Little's address was given in the East High School, which was thrown open to the public. The President's address was a most authentic and comprehensive treatment of the subject of research in America, and its statements of the extent and thoroughness of this development in our more progressive industries will be an enlightenment to all who read it. The address is printed in the October number of the *Journal of Industrial and Engineering Chemistry*, and a careful reading will undoubtedly suggest to delinquent American manufacturers that serious and genuine industrial research will offer the only means to overcome foreign competition and antiquated methods and products.

The annual banquet was held on Thursday night at the Powers Hotel. Dr. L. H. Baekeland acted as toastmaster, and the principal speakers were President Rees, of the University of Rochester, Edward W. Morley, honorary president of the eighth International Congress, President A. D. Little, C. H. Herty, of the University of North Carolina, H. E. Howe, of Bausch and Lomb Optical Company, S. L. Bigelow, of Ann Arbor, and Secretary C. L. Parsons. A delightful feature of the banquet was the orchestra music and a number of soprano solos. With the menu was distributed to each member present an engraving entitled "The Alchemist," which will long be a reminder of the Rochester meeting.

The excursions to the plants of the Bausch and Lomb Optical Company, Taylor Instrument Company, Curtice Brothers Company, J. Hungerford Smith Company, Moerlback Brewery, German-American Button Company, Genesee Reduction Company, Municipal Incinerator, Stecker Lithographic Company, and others, under the general direction of Mr. J. E. Woodland, chairman of the factory excursions committee, proved to be one of the most important features of the annual meeting. Rochester, being an industrial center, is admirably situated to provide this interesting and instructive feature of the program.

The Entertainment Committee had also made ample provision for the entertainment of the lady members and visitors in the form of a reception at the University Club, a card party at the Century Club, an excursion to Irondequoit Bay with luncheon at the Newport House, and numerous automobile excursions through the city and neighborhood of Rochester.

The success of the meeting is due to the work of the local committees and it was the unanimous opinion of the visiting members that to the Rochester Section belongs the credit of organizing and administering to the minutest detail the innumerable features which contributed to the complete success of the forty-eighth annual meeting.

The papers presented follow.

GENERAL PROGRAM

General meeting of all divisions and sections was held in Assembly Hall, Kodak Park.

The following papers were presented:

JAMES OTIS HANDY: *Copper-covered or Copper-clad Steel. The Manufacture, Properties and Uses of Composite Metal made by Alloying or Welding Copper and Steel.*

Copper is known to resist atmospheric corrosion better than zinc, tin or tin and lead alloyed. Notwithstanding this, copper has been very little used as a protective coating for iron or steel. Processes have been recently perfected for making copper-clad steel. In one process the copper is alloyed to the steel and in the other it is welded. The advantages of the welded process are: great uniformity, high conductivity and a perfect union without loss of the characteristic properties of electrolytic copper or of high-grade soft steel.

Microphotographs show clearly the difference between an alloy union of copper and iron and a weld. The line of contrast in the latter case is very sharply defined, while in the former there is a gradation or shading of one metal into the other.

Alloys of copper and iron have lower conductivity than either copper or iron, therefore welded copper and iron which contains no alloy is superior for electrical purposes and for other uses as well because of its uniformity.

The use of this material for roofing, for culverts and other sheet-metal products is sure to greatly increase.

When exposed in the Pittsburgh atmosphere a sheet of copper .04 inch thick lost less than .1 per cent. in 21 months and a copper-clad steel sheet .06 inch thick lost less than .05 per cent. There was no excessive rusting of steel at the sheared edges of the copper-clad sheet.

Potassium cyanide solution is a solvent for copper and was used as such and as an etching medium in the study of copper-clad steels.

C. E. Kenneth Mees, D.Sc.: *The Physical Chemistry of Photographic Development.*

Photographic development depends on the fact that certain reducing agents can reduce grains of emulsified silver bromide which have been exposed to light, but not grains which have not been exposed to light.

The function of exposure is to produce a nucleus which enables silver to be precipitated with a lower reduction potential of the developer than would be necessary if no nucleus were present.

The energy required to produce this nucleus is so small that only one or two molecules per grain can be affected by the exposure.

The velocity of development follows the common type of equation for a monomolecular reaction, derived from the surface as the variable; it is conditioned chiefly by diffusion processes.

Bernard C. Hesse: *The Patent Expert and the Chemical Manufacturer.*

Comparison of the general practise of American chemical manufacturers, in regard to patentable inventions, with European practise, shows that the latter provides for more care in examination of the prior art, in the preparation and prosecution of the specification and in the protection of rights under a granted patent than does the former.

The manifold advantages of having a patent expert, better called a patent chemist, primarily charged with the responsibility of attending to the above important details as well as in acting as a connecting link between the principal, the inventor, the counsel and the patent office are particularly emphasized and their advantages illustrated by reference to some actual cases; further duties, such as systematic watch over progress in the art, in general, as well as in the particular field of the principal and for his benefit, are also pointed out. The patent chemist may or may not be an integral part of the working staff, but he should be called upon at every new manufacturing or other step on the part of the principal.

Henry Leffman: *In Commemoration of the Centennial of the Publication of the Berzelian System of Symbols.* Will be published in *Jour. Amer. Chem. Soc.*

George A. Soper: *The Utilisation of Sewage.*

The authorities charged with the making of plans for the disposal of sewage are frequently met by a public demand that the sewage shall be used as fertilizer. The belief that a large manurial value can be recovered is based upon the former belief of scientists and has been kept alive by novelists and other misguided persons. The fact is that the manurial value of sewage has been greatly overestimated. Sewage contains useful fertilizing ingredients, but experience shows that, like the gold in sea water, it costs more to extract them than they are worth.

Sewage works which are capable of utilizing the manurial ingredients are of two classes: First, those in which the sewage is applied directly to land, as in agriculture, and, second, those in which the utilizable ingredients are extracted by mechanical means, such as screening and sedimentation. Neither process has thus far proved profitable.

In the sanitary disposal of sewage, the management of the settleable impurities termed sludge is considered to be the point of central difficulty. In order to extract the manurial ingredients in sewage, it will be necessary to devise some method for the production of denser sludge than is now obtainable and a satisfactory process for the further concentration of the solid matters in the sludge should be looked for.

All recent contributions of science to the art of sewage disposal have been directed almost exclusively to the disposal of the wastes without offense and as little expense as possible, the idea being to get rid of the sewage and not to attempt to make use of its manurial value.

DIVISION OF AGRICULTURAL AND FOOD CHEMISTRY

H. E. Barnard, *Chairman*

Glen F. Mason, *Secretary*

H. E. Barnard: *Laboratory Control of the Food Industry.*

The chemist is the technical adviser of the food manufacturer, both on practical questions that come up in the course of daily operations and on all points having to do with food laws. The canner and packer are just realizing that their industry is a technical, not a rule-of-thumb business and are establishing central laboratories in which much of the construction work in industry is being done.

F. C. Cook: *Bouillon Cubes.*

Ten samples of cubes collected on the New York market in the summer of 1912 were analyzed, with the following results:

The water averaged 5 per cent., the fat 1–4.5 per cent., the ash 50–74 per cent., which is practically all sodium chloride. The nitrogen bodies and undetermined material amount to 20–40 per cent. The P_2O_5 varied from .4 to 1.8 per cent., the nitrogen from 2.1 to 3.6 per cent., and the total creatinin from .49 to 1.67 per cent. The cubes consist of two thirds salt, the rest being meat extract and plant extract. A cube prepared largely from meat extract with little plant extract gives high P_2O_5, total nitrogen and total creatinin figures.

Bouillon cubes are extensively advertised and are sold on account of their flavoring and stimulating properties, rather than for any slight food value they may possess. The large per cent. of sodium chloride which need not exceed 65 per cent. is used to furnish body to the cube and to give a salty taste to the cup of water in which the cube is dissolved.

Bouillon is a clear broth, the basis of which is meat, consequently a true bouillon cube should show high creatinin and total nitrogen figures and should be prepared entirely or largely from meat stock in addition to the fat and salt present. Several of the cubes on the market contain much more plant than meat extract, and are not entitled to the name "bouillon" unless modified.

H. E. Howe: *A Refractometer for Sugar Determinations.*

Edward Gudeman: *Hydrolyses of Starch.*

W. E. Ruth: *Chemical Studies on the Lime-Sulphur-Lead-Arsenate Spray Mixture.*

The color changes resulting from mixing lime sulphur and lead arsenate are closely analogous to the color changes involved in the precipitation of lead thioarsenate.

Analyses of the resulting mixture showed that free sulphur was precipitated. The results led the writer to look for the presence of oxygen compounds of sulphur in the mixture and thiosulphate was found to be present. There was some evidence for supposing that a thioarsenate was also formed in a small quantity.

The analyses of lime sulphur showed an increase in the quantity of thiosulphate and sulfites resulting from the mixing with lead arsenate, which probably explains the claim that mixing with lead arsenate increases the fungicidal value of lime sulphur.

O. G. Marckworth: *The Commercial Utilization of Glucose and Glycerine in Modern Breads.*

Paul Poetschke: *Sulphur Dioxide in Gelatine.*

An investigation of the quantitative determination of sulphur dioxide in gelatine, giving an account of the sources of error to be avoided, together with a detailed description of a method designed to eliminate the errors described and to secure uniformity of analytical results.

Sulphur dioxide is found in gelatine, even if prepared from selected stock and without its direct addition, as shown by analyses of such preparations made in the laboratory. Absorption of sulphur dioxide takes place from the air during the drying of the gelatine.

A summary of 1,060 analyses of commercial gelatine and 36 analyses of stock used in gelatine manufacture is given.

Lucius L. Van Slyke and Orrin B. Winter: *Solubility of Casein in Dilute Acids.*

Casein, freshly prepared by precipitating skim-milk with acetic acid and washing free from acid, was treated with 100 c.c. of different acids of known strength for given periods of time at definite temperatures and the undissolved residue determined. The acids used were hydrochloric, sulphuric, lactic and acetic; strength of solutions, N/10, N/100, N/500; time of contact, 1, 5 and 15 minutes; temperatures, 15°, 25° and 42°. In general, the amount of dissolved casein increases with increase of temperature, time of contact, and concentration of acid. Hydrochloric acid dissolves most, and then come in order lactic, sulphuric and acetic.

J. A. LeClerc and L. H. Bailey: *The Effect of Rain on the Value of Hay.*

Experiments were conducted with seven kinds of hay. One thousand grams of each kind was divided into two equal portions, *A* and *B*. Portion *A* was dried, weighed, ground and analyzed. Portion *B* was similarly dried, then leached with water for 5 minutes, and then again dried, weighed, ground and analyzed. The results, based on one ton of freshly-cut hay, show a considerable loss in dry matter, protein, sugars, ash, phosphoric acid, potash and a somewhat lesser loss of fat (ether extract), pentosans, lime and magnesia.

P. B. Dunbar and W. D. Bigelow: *The Acid Content of Fruits.*

The characteristic acids of a large number of the common fruits have been identified and determined.

The acidity of plums, apples and cherries appears to be due entirely to malic acid which is

probably present, for the most part, in the free state. Currants always contain citric acid, and may or may not contain malic acid. Gooseberries contain large amounts of both malic and citric acids. In persimmons and bananas, malic acid probably occurs alone. The pomegranate and cantaloupe contain citric acid, probably without malic acid. In the watermelon, quince and peach, malic acid predominates, and citric acid is probably absent. Cranberries contain both malic and citric acid. Red raspberries contain citric acid, with malic acid present in traces, if at all. Blackberries contain citric acid in some cases, while some samples contain traces of malic acid without citric and in others neither malic or citric acids could be identified. The acid of the apricot has not been positively identified. There is present some dextrorotatory acid whose rotation is increased by the addition of uranyl acetate—possibly tartaric or dextromalic acid. The acid of the huckleberry has not been positively identified. Traces of malic acid without citric appear to be present. Tartaric acid was not found in any of the fruits examined, with the possible exception of apricots. In the case of pears, Kieffer, Le Conte, Idaho and Bartlett contain little or no malic, while citric acid appears to predominate. In all other varieties the acidity appears to be due mostly or entirely to malic acid.

The paper also includes a review of the literature on the acidity of fruits, with the results of various writers presented in tabular form.

J. A. Bizzell and T. L. Lyon: *Estimation of the Lime Requirement of Soils.*

The authors propose a modification of the method described by R. Albert[1] for estimating the lime requirement of soils. The modified method is as follows:

Place 25 grams of the air-dried soil in a Jena kjeldahl flask. Cover with 50 c.c. boiled distilled water and add 50 c.c. tenth normal barium hydroxide solution. Digest in a briskly boiling water bath for one hour with occasional shaking. Remove from the water bath, add 150 c.c. distilled water and 5 grams solid ammonium chloride. Connect the flask with a nitrogen distillation apparatus and distill. Collect the distillate (150 c.c.) in tenth normal acid, and titrate, using methyl-orange as indicator. The strength of the barium hydroxide is determined by titrating directly 50 c.c. of the solution, using methyl-orange as indicator. The difference between the two titrations, therefore, represents the amount of barium hydroxide absorbed by the soil. A correction is made for the slight decomposition of ammonium chloride when heated with soil.

[1] *Zeit. f. Angewandte Chem.*, I., p. 533.

The results obtained on 22 samples of soil accord fairly well with those obtained by the Veitch limewater method.

H. V. Tartar: *The Valuation of the Lime-sulphur Spray as an Insecticide.*

L. M. Tolman and J. G. Riley: *The Effects of Raw Materials on the Chemical Composition of American Beer.*

Floyd W. Robinson: *Food Standards and their Effect upon Food Law Enforcement.*

J. F. Snell and J. M. Scott: *The Analysis of Maple Products. II.: A Comparative Study of the Delicacy of Methods.*

The authors compare the range of variation of conductivity value, ash data and Winton, Ross and Canadian lead values in genuine maple syrup and the rates at which these data diminish as sucrose syrup is admixed.

Conductivity value shows narrowest range, Canadian lead value most rapid diminution. Winton value has much narrower range than Canadian and gives closer duplicates. In Canadian method wash water may be indifferently 80° or 100° C. and 100 or 150 c.c. Lead values on basis of fixed quantity dry matter by (1) calculation, (2) direct determination do not accord.

DIVISION OF ORGANIC CHEMISTRY

Treat B. Johnson, *Chairman*

William J. Hale, *Vice-chairman and Secretary*

E. Kohmann and Treat B. Johnson: *The Structure of Urushiol, a Component of Japanese Lac.*

S. F. Acree: *The Reactions of Both the Ions and the Non-ionized Forms of Acids, Bases and Salts.*

Wm. Lloyd Evans and Charles R. Parkinson: *The Existence of Mandelic Aldehyde in Aqueous Solution.*

Mandelic aldehyde acetal was prepared by the reduction of benzoylformaldehyde acetal, which in turn was made by the interaction of dibromacetaphenone and sodium ethylate. Mandelic aldehyde acetal hydrolyzes in the presence of sulfuric acid, both at ordinary temperature and at 0°, the intermediate compound formed undergoing a rearrangement to benzoyl carbinol. This hydrolysis takes place also by means of the water vapor of the atmosphere. The same rearrangement was ob-

served by Nef, with lactic aldehyde acetate and mandelic aldehyde acetate at 100°. On the other hand, Wohl and Lange, and Kranz have shown that lactic aldehyde is capable of existence at ordinary temperature.

C. G. Derick and O. Kamm: *The Mechanism of the Rearrangements of Dihydro-β-Napthoic Acids.*

Carl O. Johns and Emil J. Baumann: *Researches on Purines xii.: 2-Oxy-6-Methyl-9-Ethylpurine; 2-Oxy-6, 8-Dimethyl-9-Ethylpurine; 2-Oxy-6-Methyl-8-Thio-9-Ethylpurine; 2-Methylmercapto-6-Oxy-8-Thiopurine; 2-Oxy-6-Methyl-9-Ethylpurine-8-Thioglycollic Acid.*

Carl O. Johns and Emil G. Baumann: *Researches on Purines xiii.: 2, 8-Dioxy-1, 6-Dimethylpurine; 2, 6-Dioxy-3, 4-Dimethyl-5-Nitropyrimidine (α-Dimethyl-Nitrouracil).*

J. H. Ransom and R. E. Nelson: *Acyl Derivatives of o-Aminophenol.*

The work covered by this report is a continuation of that of the senior author on the molecular rearrangement of the acyl derivatives of o-aminophenol.[2] The hydrochloride of the isoamyl carbonate was prepared and identified by its properties. On warming its solution it quickly changed to the corresponding urethane. Diacyl derivatives were prepared coupling the isoamyl carbonate both with the ethyl carbonate and with the benzoyl group, and introducing these groups in reverse order. Identical diacyl derivatives resulted in both cases, without the isolation of any intermediate products. Rearrangement proceeded in the direction to leave the carbonate radical attached to the nitrogen, its weight relative to the other acyl exerting no influence on its position. In the case of both acyls being carbonates (isoamyl and ethyl) the lighter of the two is attached to nitrogen.

W. M. Blanchard: *Diacetyl: A Study in Structural Chemistry.*

L. V. Redman, A. J. Weith and F. P. Brock: *The Determination of Phenol in the Presence of Formaldehyde and Hexamethylenetetramine.*

In the regular determination of phenols by bromine or iodine the presence of hexamethylenetetramine does not interfere. Formaldehyde does interfere with the determination. If a few c.c.'s of strong ammonia be added to the mixture of phenol and formaldehyde and the solution then acidified the formaldehyde is changed to hexamethylenetetramine and the determination of the phenol may be made accurately.

[2] *Am. Chem. Journ.*, Vol. XXIII., p. 1.

L. V. Redman, A. J. Weith and F. P. Brock: *Synthetic Resins Produced by the Anhydrous Reaction between Phenols and Hexamethylene Tetramine.*

A historical review is given of the reaction which takes place in a water solution between phenol and active methylene groups.

A new reaction is presented, the anhydrous reaction between dry phenols and hexamethylenetetramine in which synthetic resins are formed and NH_3 eliminated as a by-product.

Resins of variable properties are produced, depending upon the proportions of phenol to hexa. Some resins with excess phenol are liquid at all temperatures above 30° C., others are solid at all temperatures to the point of charring.

The resins are solid or spongy, depending on the rate and degree of heating.

The last intermediate product formed before the resin becomes insoluble is endeka-saligeno-saligenin with a formula $C_9H_{80}O_{14}$.

L. V. Redman, A. J. Weith and F. P. Brock: *Varnishes and Lacquers Made from Synthetic Resins.*

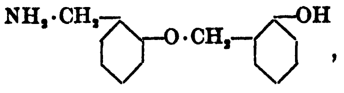
A comparison is made between synthetic resins made from phenol + formaldehyde with condensing agent and phenol + hexamethylenetetramine. The advantage of the latter process is uniformity of product. Both classes are soluble in caustic. The introduction of an inert group anisol, phenetol, etc., to block the free hydroxyl of the phenol, produces resins which satisfactorily resist the action of caustic alkalies and also show an improvement in lightness and permanency of color. The uses of varnishes and lacquers made from the resin are given.

L. V. Redman, A. J. Weith and F. P. Brock: *A New Synthetic Resin.*

This resin is formed by the anhydrous reaction between phenol, four parts, and hexamethylenetetramine, one part. Article gives description of reaction, uses, physical properties and a comparison with similar substances. Its properties, which depend upon the treatment given, are: Sp. gr. 1.2–1.3; fusibility 100° C. to infusible; hardness 2.5–4; solubility, soluble to insoluble; toughness, from that of glass to wood; tensile strength, 4,500 pounds per square inch; crushing strength, 32,000 pounds per square inch; dielectric strength, 80,000 volts per mm.; specific electrical resistance 28×10^8 megohms per cm.[3] This resin is easily moldable in almost endless variety.

L. V. Redman, A. J. Weith and F. P. Brock: *The Rate of Reaction Between Hexamethylenetetramine and Phenol.*

The rate of reaction before the insoluble stage is reached is followed by measuring the ammonia evolved. Intermediate products are formed. Amino-saligeno-saligenin,



was isolated and identified.

The rate of transformation into the insoluble stage is followed by separating the resin into (1) alkali insoluble, (2) alkali soluble and acid insoluble, (3) alkali, acid and water soluble.

Treat B. Johnson: *Chairman's Address. The Practical Utility of Hinsberg's Reaction.*

Edwin F. Hicks: *An Anomalous Reaction of Resorcinol.*

F. B. Allan and C. R. Rubidge: *The Action of Phthalic Anhydride on Benzene in Presence of Aluminium Chloride.*

F. B. Allan and H. C. Martin: *o-Benzoyl-Benzoyl Chloride and o-Benzoyl-Benzoyl Cyanide.*

A. W. Schorger: *The Oleoresins of Jeffrey and Singleleaf Pines.*

The oleoresin of singleleaf pine (*P. monophylla*) contains 19.00 per cent. of volatile oil; 79.63 per cent. colophony; trash 0.11 per cent.; water 1.26 per cent. The volatile oil, d_{15° 0.8721–.8733, a_{D20° + 14.41° to + 17.26° contains 80–85 per cent. *d*-*a*-pinene; 4–5 per cent. *l*- or *i*-limonene, 4–6 per cent. *d*-cadinene; losses 4.5 per cent. The colophony contains 7.22 per cent. resene and resin acids isomeric with abietic acid.

The oleoresin of Jeffrey pine (*P. Jeffreyi*) has an average content of 9.96 per cent. volatile oil, 87.88 per cent. colophony, 1.69 per cent. watér and 0.47 per cent. trash. The volatile oil, d_{15° .6951–.7110, contains about 95 per cent. *n*-heptane and 5 per cent. of an aldehyde apparently citronellal. The colophony contains 12.5 per cent. resene and resin acids isomeric with abietic acid.

A. W. Schorger: *The Leaf Oil of Douglas Fir.*

The oils distilled from the Douglas fir (*Pseudotsuga taxifolia*) in California had: d_{15° .8727–.8779; a_{D20° — 17.02° to — 22.17°; ester No. after acetylation 27.50–51.78; they contained: 1-*a*-pinene 25 per cent.; 1-*β*-pinene 48 per cent.; *i*- or *l*-limonene 6 per cent.; furfurol; bornyl acetate 6.1 per cent.; free alcohol as borneol 6.5 per cent.; "green oil" 3 per cent.; losses by polymerization, etc., 5 per cent.

William J. Hale: *The Condensation of Thiourea with Acetylacetone.*

Nellie Wakeman and Edward Kremers: *The Water and Volatile Oil Content of the Leaves of Monarda fistulosa.*

Although the oil of *Monarda fistulosa* had been distilled frequently, no systematic study of the exact oil content of the plant has been made thus far. Inasmuch as the leaves contain by far the largest portion of the oil that is obtained when the flowering herb is distilled, these organs were separated from the stems and distilled in the fresh condition. In order that the percentage might be computed with reference to the dry material, moisture determinations were also made. Since the oil content of the dried leaves is not inappreciable, the moisture determinations were made by the xylene method. The series of experiments here referred to were made during the spring and summer of 1911. The early material was obtained from wild plants, the later material from the medicinal herb garden, a cooperative experiment between the Bureau of Plant Industry and the University of Wisconsin. From the tabulated data it became apparent that the oil content increased with the advance of the season whether computed for the fresh or dry herb.

E. N. Doane and Edward Kremers: *The Physical and Chemical Constants of a Number of Monarda fistulosa Oil.*

Comparatively early in the study of the *Monarda* oils efforts were made to ascertain the several changes in the oil as expressed by the physical constants and phenol content. In connection with the cultivation of the wild bergamot in the medicinal herb garden, a cooperative experiment between the Bureau of Plant Industry and the University of Wisconsin, at Madison, it seemed highly desirable to ascertain what changes might be noted in connection with the oils distilled each year. For this purpose the chemical constants of the dephenolated oil (acid number, saponification number, saponification number after acetylation) as well as the physical constants of the original and dephenolated oils were ascertained. The conclusion arrived at thus far is that the metabolic processes of the plant, so far as its volatile products are concerned, appear to be subject to but slight changes in different years.

Charles L. Parsons

(*To be continued.*)

SCIENCE

FRIDAY, NOVEMBER 7, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

INDUSTRIAL RESEARCH IN AMERICA[1]

GERMANY has long been recognized as preeminently the country of organized research. The spirit of research is there imminent throughout the entire social structure. This is not the time nor place, however, nor is it necessary before this audience, to refer in any detail to the long record of splendid achievement made by German research during the last fifty years. It is inscribed in luminous letters around the rock upon which Germany now stands secure among the nations of the world.

The virility and range of German research were never greater than they are to-day. Never before have the superb energy and calculated audacity of German technical directors and German financiers transformed so quickly and so surely the triumphs of the laboratory into industrial conquests. Never has the future held richer promise of orderly and sustained progress, and yet the preeminence of Germany in industrial research is by no means indefinitely assured. A new competitor is even now girding up his loins and training for the race, and that competitor is strangely enough the United States—that prodigal among nations, still justly stigmatized as the most wasteful, careless and improvident of them all.

To one at all familiar with the disdain of scientific teaching which has characterized our industry, and which still persists in many quarters, this statement is so contrary to the current estimate that its general acceptance can not be expected. It will

[1] Presidential address at the forty-eighth meeting of the American Chemical Society, Rochester, N. Y.

have served its purpose if it leads to a consideration of the facts which prove the thesis.

The country of Franklin, Morse and Rumford; of McCormick, Howe and Whitney; of Edison, Thomson, Westinghouse and Bell; and of Wilbur and Orville Wright, is obviously a country not wholly hostile to industrial research or unable to apply it to good purpose. It is, however, not surprising that with vast areas of virgin soil of which a share might be had for the asking; with interminable stretches of stately forest; with coal and oil and gas, the ores of metals and countless other gifts of nature scattered broadcast by her lavish hand, our people entered upon this rich inheritance with the spirit of the spendthrift, and gave little heed to refinements in methods of production and less to minimizing waste. That day and generation is gone. To-day, their children, partly through better recognition of potential values, but mainly by the pressure of a greatly increased population and the stress of competition among themselves and in the markets of the world, are rapidly acquiring the knowledge that efficiency of production is a sounder basis for prosperity than mere volume of product, however great. Many of them have already learned that the most profitable output of their plant is that resulting from the catalysis of raw materials by brains. A far larger number are still ignorant of these fundamental truths, and so it happens that most of our industrial effort still proceeds under the guidance of empiricism with a happy disregard of basic principles. A native ingenuity often brings it to a surprising success and seems to support the aphorism "Where ignorance is profitable, 'tis folly to be wise." Whatever may be said, therefore, of industrial research in America at this time is said of a babe still in the cradle but which has nevertheless, like the infant Hercules, already destroyed its serpents and given promise of its performance at man's estate.

The long-continued and highly organized research which resulted in the development of American agricultural machinery has led to the general introduction of machines which reduce the labor cost of seven crops \$681,000,000 as measured by the methods of only fifty years ago.

The superhuman dexterity and precision of American shoe machinery, which has revolutionized a basic industry and reduced competition to the status of an academic question, present American industrial research at its best. They are not the result of the individual inspiration of a few inventors as is commonly supposed. They represent years of coordinated effort by many minds directed and sustained by constant and refined experimental research.

You need not be reminded that the ubiquitous telephone is wholly a product of American research. Munchausen's story of the frozen conversation which afterward thawed out is a clumsy fable. Think of the Niagaras of speech pouring silently through the New York telephone exchanges where they are sorted out, given a new direction and delivered audibly perhaps a thousand miles away. New York has 450,000 instruments—twice the number of those in London. Los Angeles has a telephone to every four inhabitants. Why should one care to project one's astral body when he can call up from the club in fifteen seconds? Our whole social structure has been reorganized, we have been brought together in a single parlor for conversation and to conduct affairs because the American Telephone and Telegraph Company spends annually for research, the results of which are all about us, a sum greater than the total income of many universities.

The name of Edison is a household word

in every language. The Edison method is a synonym for specialized, intense research which knows no rest until everything has been tried. Because of that method and the unique genius which directs its application, Italian operas are heard amid Alaskan snows and in the depths of African forests; every phase of life and movement of interest throughout the world is caught, registered, transported and reproduced that we may have lion hunts in our drawing-rooms and the coronation in a five-cent theater. From his laboratory have come the incandescent lamp, multiple telegraphy, new methods of treating ores and a thousand other diverse inventions, the development of a single one of which has sometimes involved millions.

The development of the automobile, and especially of the low-priced American car, is a thing of yesterday. To-day a single manufacturer turns out two cars a minute, while another is expanding his output to 500 cars a day. Every 23 days the total engine horse-power of new cars of one small type equals the energy of the entire Mississippi river development at Keokuk. Every 46 days this engine output rises to the total energy development at Niagara Falls. The amount of gasoline consumed upon our roads is equal to the water supply of a town of 40,000 inhabitants, and its cost on Sundays and holidays is $1,000,000.

It goes without saying that any such development as that of the automobile industry in America has been based upon and vitalized by an immeasurable amount of research, the range and influence of which extends through many other industries. It has accelerated the application of heat treatment more than any other agency. One tire manufacturer spends $100,000 a year upon his laboratory. The research department organized by my associates for one automobile company comprised within its staff experts in automobile design, mathematics, metallography and heat treatments, lubrication, gaseous fuels, steel and alloys, paints and painting practise, in addition to the chemists, physicists and assistants for routine or special work.

The beautiful city whose hospitality has so greatly added to the pleasure and success of the present meeting of our society is the home of two highly scientific industries of which any community may well be proud. The Bausch & Lomb Optical Company, through its close affiliation with the world-famed Zeiss works at Jena, renders immediately available in this country the latest results of German optical research. The Eastman Kodak Company is perhaps more generally and widely known than even the Zeiss works, and in capital, organization, value of product and profit of operation will bear comparison with the great German companies whose business is applied science. Like them, it spends money with a lavish hand for the promotion of technical research and for the fundamental investigation of the scientific bases on which its industry rests. As you have happily been made aware, this work is carried on in the superb new research laboratories of the company with an equipment which is probably unrivalled anywhere for its special purposes. The laboratory exemplifies a notable feature in American industrial research laboratories in that it makes provision for developing new processes first on the laboratory scale and then on the miniature factory scale.

To no chapter in the history of industrial research can Americans turn with greater pride than to the one which contains the epic of the electrochemical development at Niagara Falls. It starts with the wonderful story of aluminum. Discovered in Germany in 1828 by Wöhler, it cost in 1855, $90 a pound. In 1886, it had fallen to $12.

The American Castner process brought the price in 1889 to $4. Even at this figure it was obviously still a metal of luxury with few industrial applications. Hall in America and Héroult simultaneously in Europe discovered that cryolite, a double fluoride of sodium and aluminum, fused readily at a moderate temperature, and when so fused dissolved alumina as boiling water dissolves sugar or salt, and to the extent of more than 25 per cent. By electrolyzing the fused solution aluminum is obtained. On August 26, 1895, the Niagara works of the Pittsburgh Reduction Co., started at Niagara Falls the manufacture of aluminum under the Hall patents. In 1911, the market price of the metal was 22 cents and the total annual production 40,000,000 pounds.

A chance remark of Dr. George F. Kunz, in 1880, on the industrial value of abrasives, turned the thoughts of Acheson to the problem of their artificial production and led to the discovery, in 1891, of carborundum and its subsequent manufacture on a small scale at Monongahela City, Pennsylvania. In 1894, Acheson laid before his directors a scheme for moving to Niagara Falls, when to quote his own words:

> To build a plant for one thousand horse-power, in view of the fact that we were selling only one half of the output from a one hundred and thirty-four horse-power plant, was a trifle too much for my conservative directors, and they, one and all, resigned. Fortunately, I was in control of the destiny of the Carborundum Company. I organized a new board, proceeded with my plans, and in the year 1904, the thirteenth from the date of the discovery, had a plant equipped with a five-thousand electrical horse-power and produced over 7,000,000 pounds of those specks I had picked off the end of the electric light carbon in the spring of 1891.

The commercial development of carborundum had not proceeded far before Acheson brought out his process for the electric furnace production of artificial graphite and another great Niagara industry was founded. In quick succession came the Willson process for calcium carbide and the industrial applications of acetylene; phosphorus; ferro-alloys made in the electric furnace; metallic sodium, chlorine and caustic soda first by the Castner process, later by the extraordinarily efficient Townsend cell; electrolytic chlorates and alundum.

Perhaps even more significant than any of these great industrial successes was the Lovejoy & Bradley plant for the fixation of atmospheric nitrogen which was perforce abandoned. It is well to recall, in view of that reputed failure, that the present-day processes for fixing nitrogen have made little if any improvement in yields of fixed nitrogen per kilowatt hour over those obtained in this pioneer Niagara plant.

In the year 1800, a young assistant of Lavoisier, E. I. du Pont by name, emigrated to this country with others of his family and settled on the banks of the Brandywine, near Wilmington, Del. He engaged in the manufacture of gunpowder. To-day the du Pont Company employs about 250 trained chemists. Its chemical department comprises three divisions: the field division for the study of problems which must be investigated outside the laboratory and which maintains upon its staff experts for each manufacturing activity, together with a force of chemists at each plant for routine laboratory work; second, the experimental station which comprises a group of laboratories for research work on the problems arising in connection with the manufacture of black and smokeless powder, and the investigation of problems or new processes originating outside the company; third, the eastern laboratory which confines itself to research concerned with high explosives; its equipment is housed in 76 buildings, the majority being of considerable size, spread over 50 acres.

Since no industrial research laboratory can be called successful which does not in due time pay its way, it is pleasant to record that the eastern laboratory is estimated to yield a profit to its company of $1,000,000 a year. In addition to the generous salaries paid for the high-class service demanded by the company, conspicuous success in research is awarded by bonus payments of stock.

In Acheson and Hall have been already named two recipients of the Perkin medal, the badge of knighthood in American industrial research. The distinguished and thoroughly representative juries which award the medal annually had previously bestowed it upon Herreshoff for his work in electrolytic copper refining, the contact process for sulphuric acid and the invention of his well-known roasting furnace, and upon Behr for creative industrial research in the great glucose industry. In 1912, it was received by Frasch, and this year it was awarded Gayley.

The Gayley invention of the dry air blast in the manufacture of iron involves a saving to the American people of from $15,000,000 to $29,000,000 annually. A modern furnace consumes about 40,000 cubic feet of air per minute. Each grain of moisture per cubic foot represents one gallon of water per hour for each 1,000 cubic feet entering per minute. In the Pittsburgh district the moisture varies from 1.83 grains in February to 5.94 grains in June, and the water per hour entering a furnace varies accordingly from 73 to 237 gallons. In a month a furnace using natural air received 164,500 gallons of water, whereas with the dry blast it received only 25,524 gallons. A conservative statement according to Professor Chandler is that the invention results in a 10 per cent. increase in output and a 10 per cent. saving in fuel.

Especially notable and picturesque among the triumphs of American industrial research is that by means of which Frasch gave to this country potential control of the sulphur industry of the world. There is in Calcasieu Parish, La., a great deposit of sulphur 1,000 feet below the surface under a layer of quicksand 500 feet in thickness. An Austrian company, a French company and numerous American companies had tried in many ingenious ways to work this deposit, but had invariably failed. Misfortune and disaster to all connected with it had been the record of the deposit to the time when Frasch approached its problem in 1890. He conceived the idea of melting the sulphur in place by superheated water forced down a boring, and pumping the sulphur up through an inner tube. In his first trial he made use of twenty 150 h.-p. boilers grouped around the well, and the titanic experiment was successful. The pumps are now discarded and the sulphur brought to the surface by compressed air. A single well produces about 450 tons a day, and their combined capacity exceeds the sulphur consumption of the world.

An equally notable solution of a technical problem which had long baffled other investigators is the Frasch process for refining the crude, sulphur-bearing, Canadian and Ohio oils. The essence of the invention consists in distilling the different products of the fractional distillation of the crude oil with metallic oxides, especially oxide of copper, by which the sulphur is completely removed while the oils distill over as odorless and sweet as if from the best Pennsylvania oil. The copper sulphide is roasted to regenerate the copper. The invention had immense pecuniary value. It sent the production of the Ohio fields to 90,000 barrels a day and the price of crude Ohio oil from 14 cents a barrel to $1.00.

Turning from these examples of individual achievement so strongly character-

istic of the genius of our people in one aspect, let us again consider for a moment that other and even more significant phase of our industrial research, namely, that which involves the coordinated and long-continued effort of many chemists along related lines.

Chemistry in America is essentially republican and pragmatic. Most of us believe that the doctrine science for science's sake is as meaningless and mischievous as that of art for art's sake, or literature for literature's sake. These things were made for man, not for themselves, nor was man made for them. Most of us are beginning to realize that the major problems of applied chemistry are incomparably harder of solution than the problems of pure chemistry, and the attack, moreover, must often be carried to conclusion at close quarters under the stress and strain induced by time and money factors. Under these circumstances it should not excite surprise that a constantly rising proportion of our best research is carried on in the laboratories of our great industrial corporations, and nowhere more effectively than in the research laboratory of the General Electric Company under the guidance of your past president, Dr. Whitney. As to the laboratory method Dr. Whitney says in a personal letter:

> We see a field where it seems as though experimental work ought to put us ahead. We believe that we need to get into the water to learn to swim, so we go in. We start back at the academic end as far as possible, and count on knowing what to do with what we find when we find it. Suppose that we surmise that, in general, combustible insulation material could be improved upon. We try to get some work started on an artificial mica. May be we try to synthesize it and soon come to a purely theoretical question; *e. g.*, is it possible to crystallize such stuff under pressure in equilibrium with water vapor corresponding to the composition of real mica? This may lead a long way and call in a lot of pure chemistry and physical chemistry. Usually we just keep at it, so that if you haven't seen it on the market we're probably at it yet.

In striking contrast to the secrecy maintained between individual workers in large German research laboratories, is the almost universal custom in America to encourage staff discussion. In the General Electric Laboratory, as in many others, the weekly seminars and constant helpful interchange of information has developed a staff unity and spirit which greatly increases the efficiency of the organization and raises that of the individual to a higher power.

Many evenings could profitably be spent in discussing the achievements of this laboratory. Their quality is well indicated by the new nitrogen tungsten lamp, with its one half watt per candle, which combines the great work of Dr. Coolidge on ductile tungsten with the studies of Langmuir and others of the staff on the particular glass and gas and metal which are brought together in this lamp.

Any attempt to adequately present the enormous volume of research work, much of which is of the highest grade, constantly in progress in the many scientific bureaus and special laboratories of the general government or even to indicate its actual extent and range, is of course utterly beyond the limits of my attainments or of your patience. The generous policy of the government toward research is unique in this, that the results are immediately made available to the whole people. Heavy as some of the government reports are, they can not be expected to weigh more than the men who write them. Some, like the "Geochemistry" of F. W. Clarke, are of monumental character. A vast number are monographs embodying real and important contributions to scientific knowledge or industrial practise. Some, as would be expected, are little more than compilations or

present the results of trivial or ill-considered research.

The United States is still essentially an agricultural country and agriculture is, in its ultimate terms, applied photo-chemistry. The value of our farm property is already over $42,000,000,000, and each sunrise sees an added increment of millions. Even small advances in agricultural practise bring enormous monetary returns. The greatest problem before the country is that of developing rural life. While our people still crowd into already congested cities, some are beginning to realize that Long Acre Square is not a wholly satisfying substitute for Long Acre Farm, and to question whether the winding, fern-fringed country roads of Vermont may not be a better national asset than the Great White Way.

Chief, therefore, among the government departments, in the volume of industrial research is of course the Department of Agriculture, which includes within its organization ten great scientific bureaus, each inspired by an intense pragmatism and aggressively prosecuting research in its allotted field. The magnitude of these operations of the department may be inferred from the fact that it spent for printing alone during the fiscal year just ended $490,000. The activities of its army of agents literally cover the earth, and its annual expenditure runs to many millions. The Bureau of Soils, the Bureau of Plant Industry, the Bureau of Animal Industry and the Forest Service have to do with the very foundations of our national existence and prosperity, and their researches have added billions to the national wealth. The Bureau of Chemistry, through its relation to the enforcement of the pure food law and the inspection of meats before interstate shipment, is as ubiquitous in its influence as the morning newspaper and touches the daily life of the people almost as closely. The consumer is by no means the only one benefited by its activities. Manufacturers are protected from the unfair competition of less scrupulous producers. The progress of research is stimulated not only by investigations within the bureau, but by their reaction upon the manufacturers of food products who are rapidly being brought to establish laboratories of their own. The food work of the bureau is supplemented and extended by the laboratories of the state and city boards of health, of which that of Massachusetts has been notable for productive research. Special laboratories within the bureau carry its influence and investigations into other fields as in case of the paper and leather laboratory.

The office of Public Roads of the department, mindful of the fact that less than ten per cent. of the total road mileage of the country has ever been improved, maintains a large organization of engineers, chemists and other scientists to conduct investigations and compile data, the ultimate purpose of which is to secure efficiency and economy in the location, construction and maintenance of country roads, highways and bridges.

The research work of the Department of Agriculture is greatly augmented and given local application through the agency of 64 state agricultural experiment stations established for the scientific investigation of problems relating to agriculture. These stations are supported, in part, by federal grants, as from the Hatch and Adams funds, and for the rest by state appropriations. Their present income exceeds $3,000,000. All are well equipped; one of them, California, includes within its plant a superb estate of 5,400 acres with buildings worth $1,000,000.

The station work is organized upon a national basis but deals primarily with the problems of the individual states. The effi-

ciency of their work is stimulated by the requirement of the Adams Fund that appropriation shall be confined to definite projects. The number of such projects during 1910 was 335 and during 1911, 290. The reduction in number in no way implies diminished activity, and is due to more careful selection and preparation, with elimination of trivial and merely demonstrational projects. While the work of the stations necessarily covers a wide range of subjects, many of which would not be regarded as chemical in nature, a notable proportion has to do directly with chemical projects. Only the briefest reference can be made to a few of these:

At Connecticut, Osborne's studies of proteins and their feeding values have developed differences as great in their assimilability as those existing between the different carbohydrates.

Kansas has a department for the study of problems in handling and milling grain with an experimental baking plant for testing the bread-making capacity of flours. The millers are actively cooperating.

Minnesota has a similar thoroughly modern baking and testing laboratory for studies in wheat and flour chemistry and technology.

Arizona finds that date ripening may be so hastened by spraying the immature fruit with acetic acid that choice varieties are caused to ripen in that region.

The Cornell Station has demonstrated that the growth of a legume with a nonlegume gives the latter a greater protein content than when grown alone.

Wisconsin has established the significance of sulphur as a plant food; grain crops, for example, remove nearly as much sulphur as they do phosphoric acid, whereas the soil supply of sulphur is far less.

Vermont is studying the forcing of plants by means of carbonic acid gas.

Idaho has raised the protein content of wheat by 50 per cent. Kentucky has developed a method for the detection of *Bacillus typhosus* in water, and North Dakota is conducting very extensive field tests on the durability of paints and oils.

These are, of course, mere surface references which hardly touch the real work of the stations. An enormous amount of research and routine work on fertilizers is constantly carried on by methods standardized by the Association of Official Agricultural Chemists. The theory of the action of fertilizers engages the effort of many research workers who find the problem far more complex than the old plant food theory assumed.

It may be said without fear of contradiction that through the combined efforts of the Department of Agriculture, the experiment stations, the agricultural colleges and our manufacturers of agricultural machinery there is devoted to American agriculture a far greater amount of scientific research and effort than is at the service of any other business in the world.

No other organic substance occurs in such abundance as wood, and few, if any, are more generally useful. About 150,000,000 tons of wood are still wasted annually in the United States. The Forest Products Laboratory which is maintained by the Forest Service in cooperation with the University of Wisconsin has for its purpose the development and promulgation of methods for securing a better utilization of the forest and its products, and its research work is directed to that end. The laboratory is splendidly equipped with apparatus of semi-commercial size for work in timber physics, timber tests, wood preservation, wood pulp and paper and wood distillation and chemistry.

In the United States Patent Office, Dr. Hall has developed a remarkably compre-

hensive index to chemical literature which now contains 1,250,000 cards and which is open to every worker. The Bureau of Fisheries devotes $40,000 to a single study and the Geological Survey, $100,000 to the investigation of the mineral resources of Alaska. It spent, in 1913, $175,000 for engraving and printing alone. The superb Geophysical Laboratory of the Carnegie Institution of Washington is also constantly engaged in the most refined researches into the composition, properties and mode of genesis of the earth's crust. The Smithsonian Institution is honored throughout the world for the efficiency of its effort to increase and diffuse useful knowledge among men.

The Bureau of Mines of the Department of the Interior was established to conduct in behalf of the public welfare fundamental inquiries and investigations into the mining, metallurgical and mineral industries. Its appropriation for the current fiscal year is $662,000, of which $347,000 is to be devoted to technical research pertinent to the mining industry. The bureau has revolutionized the use of explosives in mines. Over $8,000,000 worth of coal is now bought on the specification and advice of the bureau while more than 50 of the larger cities, a number of states and many corporations have adopted the bureau plan of purchase. Our own Dr. Parsons, as chief mineral chemist of the bureau, is carrying its researches into new and interesting fields.

Perhaps no better evidence could be adduced of the present range and volume of industrial research in America than the necessity, imposed upon the author of such a general survey as I am attempting, of condensing within a paragraph his reference to the Bureau of Standards of the Department of Commerce. Its purpose is the investigation and testing of standards and measuring instruments and the determination of physical constants and the properties of materials. To these objects it devotes about $700,000 a year to such good effect that in equipment and in the high quality and output of its work it has in ten years taken rank with the foremost scientific institutions in the world for the promotion of industrial research and the development and standardization of the instruments, materials and methods therein employed. Its influence upon American research and industry is already profound and rapidly extending. The bureau cooperates with foreign governments and institutions, and is constantly consulted by state and municipal officials, technical bodies, commissions and industrial laboratories as a court of highest appeal.

I can not better conclude this cursory and fragmentary reference to governmental work in applied science than with the words of the distinguished Director of the Bureau of Standards:

> If there is one thing above all others for which the activities of our government during the past two or three decades will be marked it is its original work along scientific lines, and I venture to state that this work is just in its infancy.

In view of the evidence offered by Germany of the far-reaching benefits resulting from the close cooperation which there obtains between the university laboratory and the industrial plant, it must be admitted with regret that our own institutions of learning have, speäking generally, failed to seize or realize the great opportunity confronting them. They have, almost universally, neglected to provide adequate equipment for industrial research, and, what is more to be deplored since the first would otherwise quickly follow, have rarely acquired that close touch with industry essential for familiarity and appreciation of its immediate and pressing needs.

There are happily some notable exceptions. Perhaps foremost among them stands the Massachusetts Institute of Technology with its superb engineering and testing equipment, its Research Laboratory of Applied Chemistry and the meritorious thesis work of its students in all departments. The biological department has been especially active and successful in extending its influence into industrial and sanitary fields, while unusual significance attaches to the motor vehicle studies just concluded and the more recently inaugurated special investigations in electricity, since both were initiated and supported by external interests. About two years ago the institute brought vividly before the community the variety and extent of its wide-spread service to industry by holding a Congress of Technology, at which all of the many papers presented recorded the achievements of institute alumni.

The Colorado School of Mines, recognizing that $100,000,000 a year is lost through inefficient methods of ore treatment, has recently equipped an experimental ore dressing and metallurgical plant in which problems of treatment applicable to ores of wide occurrence will be investigated. The Ohio State University has established an enviable reputation for its researches in fuel engineering. Cornell has been especially alive to the scientific needs of industrial practise, and a long experience with technical assistants enables me to say that I have found none better equipped to cope with the miscellaneous problems of indusrial research than the graduates of Cornell. It may in fact be stated generally that the quality of advanced chemical training now afforded in this country is on a par with the best obtainable in Germany, and that home-trained American youth adapt themselves far more efficiently to the requirements and conditions of our industries than do all but the most exceptional German doctors of philosophy who find employment here.

Several of the great universities of the middle west, notably those of Wisconsin and Illinois, have placed themselves closely in touch with the industrial and other needs of their communities and are exerting a fundamental and growing influence upon affairs. In the east, Columbia has recently established a particularly well equipped laboratory for industrial chemistry and is broadening its work in this department.

The universities of Kansas and of Pittsburgh are carrying forward an especially interesting experiment in the operation of industrial research fellowships supported by the special interests directly concerned. These fellowships endow workers for the attack of such diverse subjects as the chemistry of laundering, the chemistry of bread and baking, that of lime, cement and vegetable ivory, the extractive principles from the ductless glands of whales, the abatement of the smoke nuisance, the technology of glass, and many others. The results obtained are intended primarily for the benefit of the supporters of the individual fellowships but may be published after three years. The holder of the fellowship receives a proportion of the financial benefits resulting from the research, and the scale of sums allotted has progressively risen from $500 a year to $2,500 and even to $5,000. While some doubt may reasonably be expressed as to the possibility of close individual supervision of so many widely varying projects, the results obtained thus far seem entirely satisfactory to those behind the movement, which has further served to strongly emphasize the willingness of our manufacturers to subsidize research.

The present vitality and rate of progress in American industrial research is strik-

ingly illustrated by its very recent development in special industries. It has been said that our best research is carried on in those laboratories which have one client, and that one themselves.

Twenty-five years ago the number of industrial concerns employing even a single chemist was very small, and even he was usually engaged almost wholly upon routine work. Many concerns engaged in business of a distinctly chemical nature had no chemist at all, and such a thing as industrial research in any proper sense hardly came within the field of vision of our manufacturers. Many of them have not yet emerged from the penumbra of that eclipse and our industrial foremen, as a class, are still within the deeper shadow. Meantime, however, research has firmly established itself among the foundation stones of our industrial system, and the question is no longer "What will become of the chemists?" It is now, "What will become of the manufacturers without them?"

In the United States to-day, the microscope is in daily use in the examination of metals and alloys in more than 200 laboratories of large industrial concerns.

An indeterminate but very great amount of segregated research is constantly carried forward in small laboratories which are either an element in some industrial organization or under individual control. An excellent example of the quality of work to be credited to the former is found in the development of cellulose acetate by Mork in the laboratory of the Chemical Products Company, while a classic instance of what may be accomplished by an aggressive individualism plus genius in research is familiar to most of you through the myriad and protean applications of bakelite. The rapidity of the reduction to practise of Baekeland's research results is the more amazing when one considers that the distances to be traveled between the laboratory and the plant are often, in case of new processes and products, of almost astronomical dimensions.

Reference has already been made to the highly organized, munificently equipped and splendidly manned laboratories of the du Pont Company, the General Electric Company and the Eastman Kodak Company. There are in the country at least fifty other notable laboratories engaged in industrial research in special industries. The expenditure of several of them is over $300,000 each a year; the United States Steel Corporation has not hesitated to spend that amount upon a single research; the expenses of a dozen or more probably exceed $100,000 annually. The limits of any address delivered outside a jail unfortunately preclude more than the merest reference to a very few. One of the finest iron research laboratories in the world is that of the American Rolling Mills Co. Equally deserving mention from one aspect or another are the laboratories of the Fire Underwriters, the National Carbon Co., the Solvay Process Co., the General Bakelite Co., Parke, Davis & Co., the Berlin Mills Co., the United Gas Improvement Co., the National Electric Lamp Association, Swift & Co., the Pennsylvania Railroad and many others.

Research in the textile industries has been greatly stimulated by the various textile schools throughout the country, of which the Lowell Textile School with its superb equipment is perhaps best known. The fermentation industries have been brought upon a scientific basis largely through the efforts of the Wahl-Henius Institute at Chicago and other special schools. In the paper industry, general research is mainly confined to the Forest Products Laboratory at Madison, its branch laboratory for wood pulp at Wausau, the Bureau

of Standards, the Paper and Leather Laboratory of the Agricultural Department, and the laboratory of Arthur D. Little, Inc., at Boston. Our own special equipment for this purpose includes, as does that of some of the other laboratories named, a complete model paper mill of semi-commercial size.

There is no school of paper-making in the country, and one of our most urgent industrial needs is the establishment of special schools in this and other industries for the adequate training of foremen who shall possess a sufficient knowledge of fundamental scientific principles and method to appreciate the helpfulness of technical research. The Pratt Institute at Brooklyn is fully alive to this demand and has shaped its courses admirably to meet it.

The steel industry in its many ramifications promotes an immense amount of research ranging from the most refined studies in metallography to experimentation upon the gigantic scale required for the development of the Gayley dry blast; the Whiting process for slag-cement; or the South Chicago electric furnace. This furnace has probably operated upon a greater variety of products than any other electric furnace in the world. Regarding the steel for rails produced therein, it is gratifying to note that after two and a half years or more no reports of breakage have been received from the 5,600 tons of standard rails made from its output. The significance of this statement will be better appreciated when we consider that in 1885 the average total weight on drivers was 69,000 pounds. It had risen to over 180,000 pounds in 1907, and reached a maximum of 316,000 pounds in that year. The weight of rails during the same period had increased from 65–75 pounds to 85–100 pounds. In 1905, conditions were so bad that out of a lot of 10,000 tons, 22 per cent. were removed the first year because of depressions in the head. In 1900, the American Railway Engineering Association took the matter in hand and studied the influence and extent of segregation of specific impurities. The work was at first confined to phosphorus but has been extended to other constituents. Fay called attention to the highly deleterious influence of sulphide of manganese.

The great railway systems have been quick to cooperate in these researches which with others of fundamental importance have been extended by the American Society for Testing Materials, the Master Car Builders' Association, and other organizations. Materials of construction have constituted a fertile subject of inquiry in the Structural Materials Testing Laboratory of the United States Geological Survey.

There could well be a further great enlargement of the field of industrial research in special industries through the initiative and support of national trade associations, to the great benefit of their membership. The American Paper and Pulp Association, for example, should subsidize studies in the utilization of waste sulphite liquors, the paper-making qualities of unused woods and fibers, the hydration of cellulose, new methods of beating the yields from rags, the proper use of alum and so on. The American Brass Founders' Association could not do better than initiate investigations into zinc losses, the physical properties of alloys, and the production of alloys to specifications defining the properties desired, the application of the electric furnace to the industry and the preparation of new alloys by electric or other methods. A similar opportunity knocks at the door of the American Foundrymen's Association. Some few associations like those of the bakers and the laundrymen are already active to good purpose; others, like the Yellow Pine Lumber Manufacturers' Association, are aroused, but to the great majority of those

powerful organizations, research is still an academic question to be discussed by their members individually if they so choose. Every industry has, however, its broad research problems, and its points especially vulnerable to research attack, among which it should be easy to select those of general interest to the industry as a whole.

There are in the country many analytical, testing and commercial laboratories, and, in most of these, special researches are conducted for clients, often with gratifying results. It is to be regretted, however, that there is not a more general appreciation among commercial chemists of the scale and quality of equipment and organization essential for really effective industrial research. As this broader viewpoint is attained, and the engineer's habit of mind acquired, we may expect a great extension of independent research, and the cessation of complaint regarding the trend of prices for analysis.

Among the relatively few private or incorporated laboratories with highly organized staff, and adequate special equipment, should be mentioned those of the Institute of Industrial Research at Washington, which has done notable work on the corrosion of metals, paint technology, canning, road material, cement and special mill problems; the electrochemical laboratories of FitzGerald and Bennie at Niagara Falls, which have so successfully specialized on the construction and operation of electric furnaces to meet the requirements of special processes and products; the ore sampling and treating plant of Ricketts and Banks, and the Pittsburgh Testing Laboratory.

Industrial research is applied idealism: it expects rebuffs, it learns from every stumble and turns the stumbling block into a stepping stone. It knows that it must pay its way. It contends that theory springs from practise. It trusts the scientific imagination, knowing it to be simply logic in flight. It believes with F. P. Fish, that, "during the next generation—the next two generations—there is going to be a development in chemistry which will far surpass in its importance and value to the human race, that of electricity in the last few years. A development which is going to revolutionize methods of manufacture, and more than that, is going to revolutionize methods of agriculture," and it believes with Sir William Ramsay that "The country which is in advance in chemistry will also be foremost in wealth and general prosperity."

With these articles of faith established in our thought, let us consider where they lead us. Within the last few days Frank A. Vanderlip, than whom no one speaks with more authority upon financial matters, has told the assembled representatives of the electrical industries that they are facing a capital requirement of $8,000,000 a week for the next five years—a total within that period of $2,000,000,000. As chemists, we are ourselves entering upon an era in which the capital demands of industries now embryonic or not yet conceived will in the not distant future be equally insistent and even more insatiable. Have we as chemists given a thought to this aspect of the development of our science, or planted the seeds of the organization which may some day cope with it? In the electrical and other established engineering professions, it is significant that the great industrial applications of the sciences involved have been in large part due to the activities of firms and organizations like Stone and Webster, J. G. White & Co., Blackwell, Viehle & Buck and the United Gas Improvement Co., which, by an orderly but inexorable evolution, passed from the status of engineers to that of engineers and bankers. Our own profession has

not yet evolved the chemist and banker, but such an evolution, or at least the close alliance of chemistry and banking is a fundamental prerequisite if the results of industrial research are to find their full fruition in America. Let me add that no field within the purview of the banker is more ripe for tillage or capable of yielding a richer harvest.

We need, however, to lead the banker to the chemical point of view, and even more do we ourselves require to be taught the financial principles involved in the broad application of chemistry to industry. To the ideals of service which inspire our profession, and which are so finely exemplified in Cottrell and made effective in the research corporation, we should add a stronger impulse to direct personal initiative in affairs. We shall need for years to prosecute a vigorous campaign for a better understanding by the general public of what chemistry is and what research is. The popular imagination is ready to accept any marvel which claims the laboratory as its birthplace, but the man in the works still disbelieves that two and two in chemical nomenclature make four. We need a multiplication of research laboratories in special industries, each with an adequate staff of the best men obtainable and an equipment which gives full range to their abilities. In nearly every case this equipment should include apparatus of semi-commercial size in which to reduce to practise the laboratory findings. Nothing is more demoralizing to an industrial organization, and few things are more expensive, than full-scale experimentation in the plant.

These laboratories should each be developed around a special library, the business of which should be to collect, compile and classify in a way to make all instantly available, every scrap of information bearing upon the materials, methods, products and requirements of the industry concerned. Modern progress can no longer depend upon accidental discoveries. Each advance in industrial science must be studied, organized and fought like a military campaign. Or, to change the figure, in the early days of our science, chemists patrolled the shores of the great ocean of the unknown, and seizing upon such fragments of truth as drifted within their reach, turned them to the enrichment of the intellectual and material life of the community. Later they ventured timidly to launch the frail and often leaky canoe of hypothesis and returned with richer treasures. To-day, confident and resourceful, as the result of many argosies, and having learned to read the stars, organized, equipped, they set sail boldly on a charted sea in staunch ships with tiering canvas bound for new El Dorados.

Arthur D. Little

SOME PALEONTOLOGICAL RESULTS OF THE SWEDISH SOUTH POLAR EXPEDITION UNDER NORDENSKIOLD

Since the days of Sir Joseph Hooker's article[1] on southern pines which was published in 1845 there has been much speculation regarding Antarctica as a center of evolution and radiation of both floras and faunas and as affording a theater for the interchange of floras and faunas between South America, Africa and Australia.[2] Outside of the deductions based on the geographical distribution of the existing biota of these three regions practically no facts have been available from Antarctica itself, particularly regarding the extinct forms of this great ice-covered land-mass.

Antarctic exploration has been very active during the past decade and popular as well as scientific interest has been greatly heightened

1 *Jour. Bot.*, Vol. 4, 1845, p. 137.

2 See recent summary by Hedley in *Proc. Linn. Soc. Lond.*, reprinted in Smithsonian Report for 1912, pp. 443–453, 1913.

of lately by Captain Amundsen's discovery of the South Pole and by the tragic fate of Captain Scott and his little band of heroes after they too had penetrated to the pole. It has, therefore, seemed worth while to bring together a brief account of the recently described paleontological discoveries, naturally laying particular emphasis on those of a paleobotanical nature.

The hardship under which Gunnar Andersson collected the splendid Mesozoic flora of Graham Land and the bag of geological specimens which Scott's party dragged along to their last camp bear eloquent testimony to a devotion not only to the ideal of science, but also to that of manhood that should be an inspiration alike to scientist and to layman.

Ten years ago not a single fossil plant was known from the 14½ million square miles of the earth's surface south of latitude 60° which roughly marks the boundary of the Antarctic continent, in fact it was not certainly known that Antarctica was really a continent and not merely an archipelago.

The paleobotanical results to be noted presently are due almost entirely to the expedition led by Dr. Otto Nordenskiöld,[3] nephew of the discoverer of the Northeast passage, and to Captain Larsen of his ship the *Antarctic*. They reached the South Shetlands in January, 1902, and the party spent two winters on Snow Hill Island, 64° 25′ S. Petrified wood and Cretaceous and Tertiary plants were collected on Seymour and Snow Hill Islands while J. Gunnar Andersson who with Lieutenant Duse was forced to pass an unprepared-for winter at Hope Bay, collected the fine series of Jurassic plants that form the basis for Halle's memoir to be discussed presently.

Captain Larsen[4] during his voyages with the *Jason* in 1892–1894 had found fossil mollusca and petrified wood on Seymour Island, as had also the English expedition, and this was one of the principal factors in deciding upon the itinerary of Nordenskiöld's expedition. The results more than justified the expectations of the explorers, for in addition to the collection of Jurassic, Cretaceous and Tertiary plants they have brought back extensive collections of Upper Cretaceous invertebrates, of Tertiary invertebrates and vertebrates, the latter including the remains of five new genera of birds and a species of *Zeuglodon*.[5]

The paleobotanical materials were turned over to Professor Nathorst, the veteran student of Arctic fossil floras, who published two preliminary announcements, the first in the *Comptes rendus* of the French Academy for June 6, 1904, entitled *Sur la flore fossile des regions antarctiques* and the second before the International Geologic Congress at Mexico City in 1906, entitled "On the Upper Jurassic Flora of Hope Bay, Graham Land."

Pressure of other work entailed his turning over the materials to other specialists for final elaboration and we now have a memoir by Dusén on the Tertiary floras, one by Gothan on the fossil woods, some of which are of Upper Cretaceous age, and a third by Halle on the Mesozoic flora.

The Jurassic flora from Hope Bay is the most extensive of these three floras and in some respects the most interesting.

Halle's memoir of the latter flora[6] is one of the most careful examples of systematic paleobotanical work that has appeared in recent years, maintaining an eminently sane point of view, and occupying middle ground between the pronounced conservatism of the English students of Mesozoic floras and the unduly sanguine work of some of the older paleobotanists, such as Saporta or Heer.

Although the method has been criticized,[7] Halle maintains, quite rightly it seems to me, that it is better to describe new species than

[3] See article in *Geogr. Jour. Lond.*, Vol. 23, February, 1904, by Nordenskiöld and others, giving a general account of the expedition. Reprinted in Smithsonian Report for 1903, pp. 467–479, pl. 1, 1904.

[4] Larsen, *Geogr. Jour.*, Vol. 4, 1894, p. 333.

[5] A summary of the results and a preliminary account of the geology is given by J. Gunnar Andersson, *Bull. Geol. Inst., Upsala*, Band 7, 1906, pp. 19–71, Pl. 1–6.

[6] A brief review by F. H. Knowlton appeared in SCIENCE, Vol. 37, pp. 763–764, May 16, 1913.

[7] Seward, *New Phyt.*, Vol. 12, 1913, p. 188.

to identify doubtful material with previously described forms, especially when widely separated either geologically or geographically, since it is subsequently much easier to reduce a new name to synonymy than to disentangle a complex agglomeration that gets distributed through the literature under a single name.

The Jurassic flora was found in a hard slaty matrix preserving large-sized and clearly outlined specimens, but not showing the venation characters especially well. The collection embraces over sixty forms, of which, however, nearly a score have not been given specific names. The Equisetales are represented by *Equisetites approximatus* sp. nov., a form closely resembling *E. rajmahalensis* Schimper from the Indian Jurassic as well as *E. Duvalii* Saporta. The Hydropterideæ are represented by well-preserved specimens of the wide-spread Jurassic species *Sagenopteris paucifolia* (Phillips) Ward. Fern fronds are abundant, twenty-five different species being represented. These include a *Dictyophyllum;* the wide-ranging Jurassic *Todites Williamsoni* (Brongniart) Seward; seven forms referred to *Cladophlebis,* four being wide-ranging Jurassic forms and two being new. Three fern species are identified with well-known forms of *Coniopteris;* eight are referred to the form-genus *Sphenopteris,* four of these being new; two new species are described in *Scleropteris;* and the doubtful genera *Pachypteris* and *Thinnfeldia* are retained with the ferns. The *Pachypteris* is considered to be identical with *P. dalmatica* F. v. Kerner, a European Cenomanian species. The *Thinnfeldia,* which is described as new and compared with *T. rhomboidalis* Ettings., *T. indica* Feistm., and *T. speciosa* (Ettings.), Seward, is not unlike *T. granulata* Fontaine from the Patuxent formation (Lower Cretaceous) of Virginia.

Fronds of the Cycadales, which are not especially common in the Arctic Jurassic, constitute a prominent element in the Hope Bay flora, some nineteen species being represented. These include a large and abundant entire type of *Nilsonia* which Halle described as a new species. Except for the fact that our east American *Nilsonia densinerve* (Font.) Berry seems to have been rarely entire and the Antarctic form constantly so, there is a similarity, almost amounting to identity, between the two, a fact which Halle has not failed to notice. Three forms are referred to Seward's new genus *Pseudoctenis,* which is close to the American Lower Cretaceous genus *Ctenopsis* Berry. Four new species are instituted in *Zamites* for types of fronds often referred to the genus *Ptilophyllum.* Six forms are referred to *Otozamites* and there is a new species of *Williamsonia,* a form identified as *Ptilophyllum,* and an unnamed species of *Cycadolepis.*

The coniferous remains are abundant and include representatives of fifteen species referred to the genera *Araucarites, Pagiophyllum, Brachyphyllum, Sphenolepidium, Conites, Stachyopitys* and *Elatocladus.* This is the least satisfactory part of the memoir, but as the genera of fossil coniferophyta are in an almost hopelessly tangled state the author can not be blamed for any shortcomings in this respect. The genus *Elatocladus* with four species is proposed as a convenient term for sterile shoots of the radial or dorsiventral type, which are not certainly referrable to established genera with known fruiting characters. Like all form-genera this is confessedly artificial and it may well be doubted if in a world where all generic and specific determinations of recent as well as fossil forms contain a more or less varying personal equation whether it helps to clarify a complex situation.

Forms conspicuously wanting are *Podozamites* and all traces of *Ginkgoales* represented in northern floras by several genera such as *Ginkgo, Baiera, Phœnicopsis, Czekanowskia,* etc. These are also wanting or only doubtfully represented in the fossil floras of India. The abundant *Zamites* and *Otozamites* fronds are also consistently smaller types than in northern floras. There are absolutely no traces of Angiosperms.

Hope Bay is in latitude 63° 15′ S. and it is, therefore, the most southerly point furnishing a flora of Jurassic age.[8] It is, therefore, re-

[8] Members of the Shackleton Expedition collected petrified wood and recorded the occurrence of a coal seam in latitude 80° S.

markable, considering its remoteness, that the flora should show so great a resemblance to that of the English Oolitic flora or the Upper Gondwana flora of India. It contains a number of forms identical with Arctic, Eurasiatic and North American Jurassic plants and adds another link in the chain of facts showing the cosmopolitan character of Jurassic floras. As regards the exact age of the Hope Bay flora Halle concludes that there is no reason to believe that it is in any considerable degree older or younger than other floras known to be of Middle Jurassic age. It seems to me that if anything it is younger, especially if the identification of *Pachypteris dalmatica* is certain. The resemblance of some of the Antarctic forms to American Lower Cretaceous species and the identification of Wealden forms, even if somewhat uncertain, is entitled to the weight which should always be given to new as against surviving types.

Regarding Jurassic climatic conditions the present contribution is of vast importance. Collected in a glaciated region where there are only two existing species of vascular plants, it presents no intrinsic evidence that would have prevented it having come from England, Italy or India. There is no dwindling of the forms or reduction of certain groups as some authors have maintained to be the case in high northern latitudes. This is all the more interesting since the recent discovery of the *Glossopteris* flora in the geographically near Falkland Islands shows that the two floral and climatic provinces of the closing Paleozoic—the northern or cosmopolitan and the *Glossopteris-Gangamopteris* type, found expression in the far south, but in terms of geologic time were of short duration.

All of Snow Hill Island and the larger southwestern part of Seymour Island, as well as a considerable area of the eastern part of Ross Island around Cape Hamilton, which is just across Admiralty Sound from Snow Hill Island, is made up of Upper Cretaceous strata, mostly sandstones. These contain rich faunas of which the ammonites, abounding in individuals and species, have been described by Professor Kilian of Grenoble.[8] The Pelecypoda, Gastropoda and Annelida have been described by Wilckens;[9] the Brachiopoda by Buckman;[10] the Echinoidea by Lambert;[11] the corals by Felix;[12] the Foraminifera by Holland,[13] and the fishes by Smith Woodward.[14] Altogether these contributions add an imposing array of Cretaceous fossils to Antarctica. The faunas indicate an older and a younger Cretaceous series of which the latter is much the richer in both species and individuals. The older is considered to correspond approximately to the Ootator group of India of lower Cenomanian age, while the younger is Senonian and shows considerable resemblance to the fauna of the Quiriquina beds of southern Chile, and to marine beds in southern Patagonia[15] made known by Steinmann and Wilckens.

Impressions of a single Cretaceous plant were found in a Nunatak group near the middle of Snow Hill Island. This has been determined by Professor Nathorst to be close to *Sequoia fastigiata* (Sternb.) Heer, a species of conifer that is not uncommon in the Cenomanian of Europe, occurring also from the Cenomanian upward into the Senonian of Greenland and also present in the Tuscaloosa formation of Alabama. It is described and figured in Halle's memoir on the Jurassic flora.

Some of the petrified woods described by Gotham come from the Upper Cretaceous, but as there is some doubt as to the horizons from which the specimens came the Cretaceous and Tertiary woods may be considered together.

Fossil wood was found on both Seymour

8 Kilian and Reboul, "Les Céphalopodes Néocrétacés," *Wissen. Ergeb.*, Band 3, Lief 6.

9 *Ibid.*, Lief 12.

10 Lief 7.

11 Lief 11.

12 Lief 5.

13 Lief 9.

14 Lief 4.

15 Wilckens has proved that the southern Patagonian beds are synchronous with the Rosa and Salamanca beds of central and northern Patagonia and included them all in what he calls the San Jorge formation.

and Snow Hill Islands. Gothan, who has described the fossil woods, has differentiated six forms, all new. Five of these are given specific names and all of the determinable forms are from Seymour Island. They are as follows: *Phyllocladoxylon antarcticum, Podocarpoxylon aparenchymatosum, Dadoxylon (Araucaria) pseudoparenchymatosum, Laurinoxylon uniseriatum, Laurinoxylon?* sp., *Nothofagoxylon scalariforme*. As I have already mentioned, there is, unfortunately, some uncertainty as to their exact age. Part of the specimens representing the *Phyllocladoxylon* are Tertiary and the balance are Upper Cretaceous or Tertiary. The *Podocarpoxylon* is given as Tertiary and the balance may be either Upper Cretaceous or Tertiary. In either case they show that types now regarded as South American or Australasian were much more wide-spread in the early Tertiary or late Cretaceous. It is of some interest to find structural remains of Araucarieæ, Lauraceæ and *Nothofagus*, since these three types are also represented in the leaf impressions studied by Dusén.

The northeastern portion of Seymour Island is made up of Tertiary beds. These are mostly marine calcareous sandstones, but with some tuffs containing augite-porphyrite. In these sandstones Nordenskiöld discovered leaf impressions which Nathorst reported upon in his brief paper of 1904.[16] They have been monographed by Dusén.[17] The material is abundant but very fragmentary. Dusén recognizes 87 different forms, of which only 25 receive specific names. Both the results and their method of presentation are open to criticism. While Dusén has brought to the work an extensive acquaintance with the existing flora of South America, it does not appear that he has an equal knowledge of paleobotanical literature and there is a tendency to see an undue resemblance to the existing flora he seems to know best.

There are 26 different *Phyllites* sp., some of which are Angiosperms and some Gymnosperms. Of the 37 different ferns only nine are identified and we are treated to the abominable array of 10 *Sphænopteris* sp., and 18 *Pecopteris* sp., both form-genera that should really be reserved for Paleozoic fern-like remains, *Sphenopteris* being partly, and presumably wholly, Pteridospermic and *Pecopteris* being filicalean. With the exception of a *Fagus* previously described by Dusén from the Straits of Magellan and a *Nothofagus* described by Engelhardt from the same region, all of the named species are new to science. They include forms in the following genera: *Miconiiphyllum, Lauriphyllum, Mollinedia, Araucaria, Polypodium, Asplenium, Alsophila, Dryopteris, Caldcluvia, Laurelia, Drimys, Lomatia, Knightia, Fagus, Nothofagus*, and *Myrica*.

The first eight of these have their closest affinities with forms in the existing subtropical flora of southern Brazil, while the balance resemble existing species of West Patagonia and southern Chili. Dusén concludes that this mixed character is due to differences in altitude at which the Seymour Island plants grew. This may well be the case, but on the other hand the author is apparently unaware of the polar extension of more equatorial climates with a mixing of types since associated with temperate or tropical conditions that occurs in the early Tertiary, or to the general lack of well-defined climatic zones in the history of the earth throughout geological times. Many attempts have been made to emphasize the fact that climates like that of the present or the Pleistocene, of which the present is really a part, or of *Glossopteris* time, or of earlier glacial periods, were the exception and not the rule when all geological time is considered. The consequent lack of extreme cold in the Tertiary when accompanied by sufficiently humid conditions would answer for the Seymour Island Tertiary flora equally as well as an altitudinal zonation.

According to Dusén this flora is typically South American, with only slight relationships to the flora of New Zealand (cf. *Laurelia*) and Australia (cf. *Knightia*). This is perhaps what would be expected since both tectonically and petrographically Graham Land

16 *Comptes rendus, loc. cit.*

17 Lief 3, 1908.

seems to represent a southward extension of the Andean axis. At the same time, it seems to me that a more critical analysis of the flora by a student qualified to compare it with the living and fossil floras of Australia, New Zealand and with more northern Tertiary floras, would bring out a good many significant features that remain hidden in Dusén's work.

Regarding the age of the Seymour Island Tertiary, Dusén, relying on comparisons with the fossil floras from the Straits of Magellan and Chili and on the affinities of the associated Mollusca, as communicated by Wilckens, concludes that it is late Oligocene or early Miocene. I would be much more inclined to consider its age as somewhat older and corresponding roughly to that of the Arctic Tertiary floras, which in turn are contemporaneous or slightly younger than those in lower latitudes that are marked by that northward extension of tropical climates which commences in the early Eocene and culminates in this country in the Vicksburg and Apalachicola groups.

EDWARD W. BERRY
JOHNS HOPKINS UNIVERSITY,
BALTIMORE

SCIENTIFIC NOTES AND NEWS

SIR WILLIAM OSLER has accepted an invitation to deliver the principal address at the opening of the James Buchanan Brady Urological Clinic of the Johns Hopkins Hospital.

THE annual Huxley Memorial Lecture of the Royal Anthropological Institute will be delivered on November 14, by Professor W. J. Sollas, F.R.S., who will take as his subject "Paviland Cave."

THE council of the Royal Meteorological Society has awarded the Symons gold medal to Mr. W. H. Dines, F.R.S. The medal will be presented at the annual meeting of the society on January 21.

THE Baly medal of the Royal College of Physicians of London has been presented to Dr. John Scott Haldane, F.R.S., reader in physiology in the University of Oxford. The medal was founded by Dr. Frederic Daniel Dyster in 1866 in memory of William Harvey, and is awarded every alternate year. The last five recipients have been Professor J. N. Langley, F.R.S. (1903), Professor Pawlow, of St. Petersburg (1905), Professor E. H. Starling, F.R.S. (1907), Professor Emil Fischer, of Berlin (1909), and Professor W. D. Halliburton, F.R.S. (1911).

ON the recommendation of the committee on the award of the Hodgkins prize of $1,500 for the best treatise "On the Relation of Atmospheric Air to Tuberculosis," which was offered by the Smithsonian Institution in connection with the International Congress on Tuberculosis held in Washington in 1908, the institution announces that the prize has been equally divided between Dr. Guy Hinsdale, of Hot Springs, Virginia, for his paper on "Tuberculosis in Relation to Atmospheric Air," and Dr. S. Adolphus Knopf, of New York City, for his treatise on the "Relation of Atmospheric Air to Tuberculosis." The members of the committee on award were: Dr. William H. Welch, John Hopkins University, Baltimore, Md., *chairman;* Dr. Hermann M. Biggs, New York City; Professor W. M. Davis, Cambridge, Mass.; Dr. G. Dock, Washington University Medical School, St. Louis, Mo.; Dr. Simon Flexner, Rockefeller Institute for Medical Research, New York City; Dr. John S. Fulton, Baltimore, Md., and Brig. Gen. George M. Sternberg, U. S. A. (retired), Washington, D. C.

PROFESSOR R. BURTON-OPITZ, of the College of Physicians and Surgeons, Columbia University, has been elected president of Alpha Omega Alpha, the honorary medical society, which now has chapters in the seventeen most representative medical colleges.

MR. H. N. BAKER, assistant superintendent of the National Zoological Park at Washington, has resigned to become superintendent of the Boston Zoological Garden.

DR. ROBERT MATHESON, formerly provincial entomologist of the Province of Nova Scotia, has recently resigned to accept the position of investigator in entomology in Cornell Agricultural Experiment Station, Ithaca, N. Y.

MR. BASCOMBE BRITT HIGGINS, Ph.D. (Cornell, '13), has been appointed botanist and plant pathologist of the Georgia Experiment Station. Dr. Higgins began his work in Georgia early in October.

PROFESSOR GEORGE V. N. DEARBORN, of the Tufts College Medical and Dental School, has been appointed consulting physiologist to the Forsyth Dental Infirmary, Boston.

W. J. WINTEMBERG has been appointed preparator in archeology in the Geological Survey Branch of the Department of Mines, by the Civil Service Commission of Canada.

THE council of the Victoria Institute has appointed Mr. E. Walter Maunder to the secretaryship of the institute, vacant by the death of Mr. F. S. Bishop. Mr. Maunder will retire on November 4 from the Royal Observatory, Greenwich, where he has been superintendent of the Solar Department for 40 years.

PROFESSOR C. G. BARKLA, recently elected to the chair of natural philosophy in the University of Edinburgh, gave his inaugural lecture on October 16, Principal Sir William Turner presiding. The subject of the address was, "What we know of Electricity."

THE Bradshaw Lecture before the Royal College of Physicians of London was delivered on November 4 by Dr. T. R. Glynn, professor of medicine in the University of Liverpool, whose subject was "Hysteria in some of its aspects." Two Fitz-Patrick Lectures were announced to be delivered on November 6 and 11 by Dr. C. A. Mercier, on "Astrology in medicine."

DR. HERMANN ARON, who made important contributions to electrial engineering, has died at the age of sixty-eight years.

M. CHARLES TELLIER, the inventor of the cold storage system, has died at eighty-six years of age.

THE U. S. Civil Service Commission announces an examination for assistant in agricultural technology, for men only, on December 3, to fill vacancies in the Bureau of Plant Industry, Department of Agriculture, at salaries of from $1,250 to $2,250.

IN connection with the sixth international congress of mathematicians, to be held in Stockholm in 1916, King Gustav V. of Sweden has founded a prize, consisting of a gold medal bearing a portrait of Weierstrass and a cash sum of 3,000 crowns, for the best contribution to the theory of analytic functions.

THE annual joint meeting of the American Anthropological Association and the American Folk-lore Society will be held in the American Museum of Natural History, New York City, December 29–31. Titles of papers and abstracts should be sent not later than December 1 to Professor George Grant MacCurdy, Yale University Museum, New Haven, Conn., who is responsible for the joint program. The program will be mailed to members about the tenth of December.

THE American Mathematical Society has accepted the invitation of Brown University, extended through the committee on the celebration of her one hundred and fiftieth anniversary to hold its fall meeting at Brown University in September, 1914.

THE *London Times* says that Dr. Mawson and his comrades, who were practically marooned in the Antarctic by the sudden onset of winter last year, are still stranded. Like nearly every other polar expedition of recent years, this exploration party started south without having the definite assurance that it would receive sufficient financial support to enable it to complete its undertaking. The Australian state governments voted Dr. Mawson £20,000 and the commonwealth government £5,000, but these amounts, together with other public and private donations, have not covered the cost of the expedition. At the present moment its liabilities amount to about £11,000 and its assets total some £5,000. It requires the difference, £6,000, to bring the members of the expedition back to Australia, when the relief ship *Aurora* can reach them. Appeal has been made to the commonwealth government by Professor David, of Sydney, for a further vote of £5,000, and it is hoped that the extra £1,000 will be raised by private subscriptions.

THE Philadelphia Pathological Society will held at the College of Physicians, on November 20, at 8:15 P.M., a symposium on the subject of "Physical Growth and Mental Development." The speakers will be Dr. H. H. Donaldson, of the Wistar Institute, "Studies on the Growth of the Central Nervous System"; Professor Bird T. Baldwin, of Swarthmore College, "The Normal Child; Its Physical Growth and Mental Maturity," and Professor Lightner Witmer, of the University of Pennsylvania, "Children with Mental Defects Distinguished from Mentally Defective Children." The discussion to be opened by Dr. H. H. Goddard, of the New Jersey Training School, Vineland, N. J., Dr. Charles Burr, of Philadelphia, and Professor J. H. Leuba, of Bryn Mawr College.

WE learn from the report in the London *Times* that the International Tuberculosis Conference held its first meeting in the Lower House of the Prussian Diet, Berlin, on October 23. Dr. Franz Bumm presided in the absence of M. Léon Bourgeois. The conference was welcomed by the secretary of state for the Imperial Ministry of the interior, Dr. Delbrück, who observed that the conference was meeting at the place where the international organization was founded eleven years ago under the patronage of the German empress. It now embraced the whole world and united the nations in a common labor for humanity. Speaking of the fight against tuberculosis in Germany, Dr. Delbrück said that there were now 147 sanatoria, with 15,278 beds. There were 103 institutions, with more than 9,000 beds, for children threatened with tuberculosis, 114 forest sanatoria, and 17 forest schools. Dr. Delbrück called special attention to the movement for the addition of wings to hospitals rather than for the building of sanatoria, and said that there were now more than 200 tuberculosis wings of general hospitals in Germany. He observed that England held the lead in the matter of notification, and referred to the new movement in Germany for the isolation of cases in an advanced stage of the disease. This point was endorsed by the medical officer of health for Berlin, who announced that a special tuberculosis hospital, with 1,000 beds, is to be built here. Dr. Delbrück said that within about fifteen years the mortality due to tuberculosis had declined by one third in England, Germany, France, Belgium and the United States, and by one fifth in Austria, Switzerland and the Netherlands.

Nature states that in his evening lecture to the British Association at Birmingham on September 16, Dr. Smith Woodward took the opportunity of replying to Professor Arthur Keith's recent criticisms on his reconstruction of the Piltdown skull. It will be remembered that Dr. Woodward regarded the mandible as essentially that of an ape, and restored it with ape-like front teeth, while he determined the brain-capacity of the skull to approach closely the lowest human limit. Professor Keith, on the other hand, modified the curves of the mandible to accommodate typically human teeth, and reconstructed the skull with a brain-capacity exceeding that of the average civilized European. Fortunately, Mr. Charles Dawson has continued his diggings at Piltdown this summer with some success, and on August 30, Father P. Teilhard, who was working with him, picked up the canine tooth which obviously belongs to the half of the mandible originally discovered. This tooth corresponds exactly in shape with the lower canine of an ape, and its worn face shows that it worked upon the upper canine in true ape fashion. It only differs from the canine of Dr. Woodward's published restoration in being slightly smaller, more pointed and a little more upright in the mouth. Hence, there seems now to be definite proof that the front teeth of *Eoanthropus* resembled those of an ape, and its recognition as a genus distinct from *Homo* is apparently justified. The association of such a mandible with a skull of large brain-capacity is considered by Dr. Woodward most improbable, and he has made further studies of the brain-case with the help of Mr. W. P. Pycraft, who has attempted a careful reconstruction of the missing base. Dr. Woodward now concludes that the only alteration necessary in his original model is

a very slight widening of the back of the parietal region to remedy a defect which was pointed out to him by Professor Elliot Smith when he first studied the brain-cast. The capacity of the brain-case thus remains much the same as he originally stated, and he maintains that Professor Keith has arrived at a different result by failing to recognize the mark of the superior longitudinal sinus on the frontal region and by unduly widening that on the parietal region. It is understood that Mr. Dawson and Dr. Woodward will offer an account of the season's work to the Geological Society at an early meeting, and Professor Elliot Smith will include a detailed study of the brain-cast of *Eoanthropus* in a memoir on primitive human brains which he is preparing for the Royal Society.

LEONARDO DA VINCI left a number of anatomical drawings with descriptions which are now in the Royal Library at Windsor, after lying hidden in the Ambrosia Library, Milan, for centuries. The *British Medical Journal* states that photographs of these, with English and German translations of the descriptions, have been prepared by Ove C. L. Vangensten, A. Fonahn and H. Hopstock, and published by Jacob Dybwad, of Christiania. Dr. Hopstock is prosector of anatomy in the University of Christiania, where Dr. Fonahn is professor of the history of medicine, and Mr. Vangensten, professor of Italian. The first volume ("Quaderni d'Anatomia," I.), published in 1911, contains 13 folios, 22 pages in facsimile (collotype), and 70 designs. The subjects illustrated are respiration, the alternating motions of the diaphragm and the muscles of the abdomen, together with the passage of the food through the alimentary canal, and the heart. A special volume on the heart ("Quaderni d'Anatomia," II.), containing 24 folios, 33 pages in facsimile (collotype) and 240 designs, was published in 1912. The third volume, which appeared in September of the present year, consists of 12 folios, 20 pages in facsimile (collotype), dealing with the organs of generation. The remainder of the hitherto unpublished Windsor papers will follow, one volume appearing annually in September. The whole work will comprise six volumes. The Professor Voss prize has been awarded to the editors by the University of Christiania.

UNIVERSITY AND EDUCATIONAL NEWS

THERE is under construction at Smith College a biological hall for which the trustees have appropriated $140,000. Hitherto the departments of physics, zoology and botany have done most of their work in Lilly Hall. With the completion of the new building this hall will be left entirely to physics.

A SECOND gift of $10,000 from Mr. Melville H. Hanna, to Union College, is announced.

LAFAYETTE COLLEGE has received $90,000 for a chapel from a donor whose name is withheld.

AN anonymous friend has presented to the University of Leeds £10,000 for the erection of a school of agriculture.

BY the will of the late Henry Follett Osler the University of Birmingham is to receive the sum of £10,000, with a prospective share in the residuary estate.

CORNELL UNIVERSITY MEDICAL COLLEGE opened on October 1, with an enrollment as follows: For the degree of M.D.: first year, 36; second year, 32; third year, 20; fourth year, 20; special students (work not leading to the degree M.D.), 5; for the degree of Ph.D., 2; for the degree of M.A., 2; making a total of 117. All students now registered, with the exception of those pursuing the combined seven years course leading to the degrees of A.B. and M.D., are graduates of arts or science, or doctors of medicine doing advanced work.

PROFESSOR WILLARD C. FISHER, whose forced resignation from the chair of economics and sociology at Wesleyan on the alleged ground of his views on Sabbath observance will be remembered, has been appointed lecturer on economics at Harvard University for the current academic year.

THE trustees of The Ohio State University have made the following promotions: Charles St. John Chubb, Jr., C.E., to be professor of architecture; Dana James Demorest, B.S.C., to be professor of metallurgy; Harry Clifford Ramsower, B.S.C., to be professor of rural

engineering; Carl Bertram Harrop, E.M., to be assistant professor of ceramic engineering; Aubrey Ingerson Brown, M.E., to be instructor in mechanical engineering. Mr. Franklin Wales Marquis, M.E., of the University of Illinois, has been appointed professor of steam engineering to succeed Mr. E. A. Hitchcock, M.E., who resigned last spring to accept a position as sales engineer with E. W. Clark & Co.

Mr. G. D. Horton, M.S. (Yale, '13), has been appointed instructor in bacteriology in the Oregon Agricultural College.

Miss E. M. Pinney, formerly instructor in zoology, at the University of Kansas, has been appointed demonstrator in biology in Bryn Mawr College, to succeed Dr. Harriet Randolph, who is at present in Europe.

The following appointments have been made at the University of Birmingham: Mr. L. J. Wills, assistant lecturer in geology and geography; Mr. David Brunt, lecturer in mathematics (to succeed Mr. S. B. McLaren); Dr. C. L. Boulenger, reader in helminthology; Mr. H. G. Jackson, assistant lecturer in zoology.

DISCUSSION AND CORRESPONDENCE

LABELING MICROSCOPIC SLIDES

To the Editor of Science: Two things are absolutely essential to properly prepared microscopic slides; these are permanent labels and cleanliness. I have been interested in two notes that have recently appeared in Science, namely, one by Zea Northrup in the July 25 issue and, the other, by Ernest S. Reynolds, in the September 12 number. The paper labels usually affixed to the slides of a study or loan collection soon become soiled and the data more or less effaced. To obviate this, several years ago I commenced to use small and very thin paper slips upon which the data were written in "Higgin's Waterproof (Black) India Ink," placed under the cover-glass at one of the angles and in this way mounted with the specimens. I have observed this method in use at several institutions. This technical procedure permits dipping of the slides into water and their subsequent cleaning and polishing with a soft cotton cloth. The covering of the India ink label with balsam and cover-glass, as recommended by Reynolds, is an excellent method. I do not think it wise to trust to "merely printing or writing the necessary description upon the slide with India ink" as recommended by Northrup. A person can not always be sure that the writing surface is free from oily matter. Disappointment frequently attends this procedure. For some time I have used the following method: The essential data are neatly written or printed across one end of the slide as close as possible to the cover-glass and, after the ink has dried, a thin layer of Canada balsam in xylol—two to one—is painted with a camel's hair brush across the slide over the label. After the balsam has become thoroughly hardened the slide can be dipped into cold water and cleaned with a soft cotton cloth, as above. Care should at all times be taken to avoid having the slides come in contact with alcohol or xylol. Should such a thing happen the surface of the balsam can be restored by reapplication of the thin balsam. The first slide of a series or set should bear a paper label as well as the ink inscription.

Frank E. Blaisdell

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Medical Department of
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A NORTHERLY RECORD FOR THE FREE-TAILED BAT

On the morning of August 15, 1913, I picked up a live male free-tailed bat (*Nyctinomus mexicanus* Saussure) on the pavement on the main business street of Lincoln, Nebraska. It was huddled against the wall at the corner of what is probably the most brilliantly lighted building on the street where it was presumably attracted by the illumination the previous night. The specimen is now in the author's collection where it has been seen by Mr. Vernon Bailey, of the U. S. Biological Survey, who has verified the determination.

This bat normally occurs in the United States in the Lower Sonoran fauna of Texas,

Arizona and California. Four specimens were taken at Newcastle, Colorado, on July 16, 1907, by E. R. Warren,[1, 2] the locality being situated on a narrow tongue of Upper Sonoran almost surrounded by Transition but connected by a belt of the Upper Sonoran across Utah with the Lower Sonoran in Arizona, part of the regular habitat of the species.[2] A free-tailed bat, referred to this form, was collected at Manhattan, Kansas, in 1884, by Dr. C. P. Blachly.[3] This latter locality is Carolinean, but is not decidedly distant from the Austroriparian of the Lower Austral zone of southern Kansas and is connected by this with the lower Sonoran fauna in Oklahoma (and possibly in south central Kansas, locally), which latter area is an unbroken northward extension of the Lower Sonoran of Texas where the free-tailed bat is abundant.[4] It seems likely that the Manhattan individual reached Kansas from Texas by this course across Oklahoma and the Lincoln occurrence is probably due to a still more northward extension of the same route, although Lincoln is about two hundred and fifty miles from the boundary of the Lower Austral zone. Possibly the excessive heat and dryness of the past summer in Kansas and southern Nebraska had something to do with the appearance of this bat of the far southwest at a locality so distant from its normal range.

JOHN T. ZIMMER
UNIVERSITY OF NEBRASKA,
LINCOLN, NEBR.,
September 12, 1913

SCIENTIFIC BOOKS

Problems of Life and Reproduction. By MARCUS HARTOG. G. P. Putnam's Sons. 1913. Pp. 382, 41 text figures.

This volume consists of a series of eleven chapters dealing for the most part with cytological questions relating to the mechanism of heredity, but in part also with general subjects, such as the teaching of nature study. It is, indeed, a collection of biological and philosophical essays published during the period from 1892 to 1910 and here reworked and modernized, to a degree, by interpolation or rewriting. There is lacking any sustained theme except such as is furnished by the consideration of vital processes in some form.

The work was first conceived as a general treatise on reproduction for the non-scientific public, but in its present form, although a reprint of articles already published, is evidently again addressed largely to scientists. If this were not so it would be little read, for there is no lack of technical expressions and the author rarely resists the temptation to increase the number of these by the transformation of common terms into Latin forms.

The attitude of the author is controversial and he announces in the preface that he has "not hesitated to use all the legitimate arms of scientific controversy in assailing certain views." He inveighs strongly against the practise of those writers who present the opinions of any one school as the verdict of biologists in general, but is himself not entirely guiltless of such emphasis on his own conclusions. There appear frequent claims for priority of observation—and especially of theories, not a few of which are the common property of all who generalize. There is apparent the customary European lack of information concerning biological America, the result of which in this case has led the author to explain the processes of fertilization as one bringing about "rejuvenescence." As proof of this he advances the questionable work of Maupas upon the Protozoa in apparent ignorance of the convincing work of Jennings to the contrary. Since some of the essays were written a decade or two ago, there is sometimes lacking a modern viewpoint in the discussion, and even modern evidence is sometimes wanting. The search for ultimate explanations also leads to the assignment of names to conditions or relations which are then regarded as having been explained. Aside

[1] E. R. Warren, "Further Notes on the Mammals of Colorado," p. 85, 1908.

[2] Merritt Cary, "A Biological Survey of Colorado," N. A. Fauna, No. 33, pp. 204–205, 1911.

[3] D. E. Lantz, "Additions and Corrections to the List of Kansas Mammals," *Trans. Kansas Acad. Sci.*, XX., Part II., p. 216, 1907.

[4] Vernon Bailey, "Biological Survey of Texas," N. A. Fauna, No. 25, pp. 215–216, 1905.

from these lapses the author shows strength, vigor and clearness in his method, and however much one may differ from him regarding facts or theories there can be no denial of the individuality or consistency of his views.

Among the diversity of subjects considered certain themes stand out because of emphasis and repetition. Briefly these may be stated as follows: Sexual reproduction is a process for securing rejuvenescence; fertilization effects a cellular reorganization by bringing nuclear material into new cytoplasmic surroundings; reduction is a process to check the indefinite multiplication of chromosomes whose important constituent, the linin, is mechanically divided by the splitting of the chromatin granules; cell division is due to a "new force, mitokinetism," confined to living matter; heredity is not to be explained through the action of any germ plasm, but "can only be elucidated by the light of mental, not material processes"; acquired characters are inherited; such collateral inheritance receives an explanation through the operation of "unconscious memory" according to the theories of Hering and Butler; chemical and physical laws are not sufficient to account for the activities of organisms and we must assume a "vital behavior."

From all of which it is easily seen that Professor Hartog may be classed, philosophically, as a vitalistic Lamarckian. While he strikes vigorous blows in defense of his faith, it must be admitted that he brings little that is new or convincing in proof. It seems impossible not to believe that the reproductive elements are in some way and to some degree affected by conditions external to them, but it brings slight comfort and mental satisfaction to have offered as proof of such a fundamentally important principle the case of two normal children who are supposed to inherit a peculiar habit of writing because a myopic-astigmatic father has developed this as a result of his defective sight. Although the children fail to inherit the structural defect, and the father under corrected vision spontaneously loses the habit at the age of fifteen, they are reported to have it so firmly engrafted upon them as to make its eradication almost impossible. While the writer considers Lankester's logical presumption against the sudden fixation of slight influences through the soma upon the germ cells—in the face of a long adverse phylogenetic history, he does not make a satisfactory answer to it. Much more probable seems the gradual, cumulative effect of a persistent, long-continued influence upon successive generations which finally is able to overbalance the weight of the racial inertia. This would seem to account for the universal failure of experimental proof in support of the theory of inheritance of acquired characters—a theory which seems to be logically correct and which makes such a strong appeal to those who study extensive racial histories.

More scientific is the author's treatment of the problems of maturation and fertilization, although to many there will occur objections that weigh strongly against some of his conclusions. Why so general and apparently important a process as the reduction division should have become established merely to prevent indefinite multiplication of the chromosomes does not receive adequate explanation. Likewise there is no convincing evidence for the conclusion that the linin is the important part of the nuclear substance, for which the chromatin plays merely the mechanical rôle of a dividing agent. Surely Professor Hartog can not have made a careful study of the nucleus during the long and significant growth period preceding the first maturation division or he would not say (p. 138) "whatever be the function of the chromatin in the '*working*' cell, as we may term it, it is evidently less important than its function in the *dividing* cell."

The striking character of the fully established mitotic figure evidently makes a strong appeal to the author, for besides the conclusion just quoted he is led, from the conditions of the bipolar figure, to postulate an entirely new force, mitokinetism, to account for cell division. The whole argument for the new force is based upon the bipolar spindle, yet nothing is more evident than the fact that this

is but the culmination of a long series of changes which have been taking place both within and without the nucleus. All of these changes are ascribed by Professor Hartog to the operation of other physical and vital forces which are finally succeeded by the "new force" which comes into operation upon the establishment of the spindle-shaped figure. The efforts of many who would explain the process of mitosis through the action of various chemical and physical laws have failed through inadequacy of the explanations to meet all the conditions of the process. It does not seem that the author has been more successful by first proclaiming an absolute divorce between nuclear division and cell division and then invoking a new force to complete the broken contract.

For those who enjoy philosophical debate and formal explanations there will be much of interest in Professor Hartog's discussion of vitalism and of heredity through the operation of universal and unconscious memory. Very readable is his appreciation of the work of Samuel Butler. The teacher will find sound argument for natural as opposed to strictly logical methods of teaching in the chapter on "Interpolation in Memory." In the final chapter on "The Teaching of Nature Study" there is much sound pedagogical wisdom and moral support for those who would have such work taught in a way to make it worth the while of the student.

C. E. McCLUNG

Modern Research in Organic Chemistry. By F. G. POPE, B.Sc. (Lond.), F.C.S., Lecturer on Organic Chemistry, East London College. New York, D. Van Nostrand Company. 1913. $5\frac{1}{2} \times 7\frac{1}{2}$, Cloth. Pp. xi + 324. With 261 diagrams. Price $2.25 net.

This book is an attempt to bring before the student of chemistry a brief account of the development of some of the more important chapters of organic chemistry. It is the American reprint of the English book with the same title published by Methuen and Co. in London in 1912. It contains an introduction by Professor J. T. Hewitt and nine chapters which have no connection with each other. These chapters are: I., The Polymethylenes; II., The Terpenes and Camphors; III., The Uric Acid or Purine Group; IV., The Alkaloids; V., The Relation between the Color and Constitution of Chemical Compounds; VI., Salt Formation, Pseudo-acids and Bases; VII., The Pyrones; VIII., Ketenes, Ozonides, Triphenylmethyl; IX., The Grignard Reaction.

In each chapter methods of preparation, for the most part synthetical, are given and the reactions of some of the best known representatives of the different classes of compounds are discussed, especially those which are used to determine the structural formulas of the compounds. Throughout the book structural formulas are used almost exclusively. At the end of each chapter there is a bibliography containing a list of the more important papers on the subject matter of the text, so that the student may consult the original articles if he desires to do so. The book is very difficult reading, but for those to whom the original papers are not available and who wish a brief résumé of the researches on which the structure of these compounds is based, it will probably prove useful.

In a book with such a title we should naturally expect something to be said of the researches on the carbohydrates, on the synthesis of indigo and of india-rubber, but no mention is made of these very important chapters of organic chemistry.

W. R. ORNDORFF

SCIENTIFIC JOURNALS AND ARTICLES

THE October number (Vol. 14, No. 4) of the *Transactions of the American Mathematical Society* contains the following papers:

Maxime Bôcher: "Applications and generalizations of the conception of adjoint systems."

E. J. Wilczynski: "On a certain class of self-projective surfaces."

G. A. Miller: "On the representation groups of given abstract groups."

Dunham Jackson: "On the accuracy of trigonometric interpolation."

G. D. Birkhoff: "On a simple type of irregular singular point."

John McDonnell: "On quadratic residues."

H. M. Sheffer: "A set of five independent postulates for Boolean algebras, with application to logical constants."

Mildred Sanderson: "Formal modular invariants with application to binary modular covariants."

THE opening (October) number of Vol. 20 of the *Bulletin of the American Mathematical Society* contains: "Note on the gamma function," by G. D. Birkhoff; "Some properties of space curves minimizing a definite integral with discontinuous integrand," by E. J. Miles; "The degree of a cartesian multiplier," by D. R. Curtiss; "On closed continuous curves," by Arnold Emch; "Let us have our calculus early" (review of Mercer's "Calculus for Beginners"), by E. B. Wilson; "Shorter Notice": Ziwet and Field's "Introduction to Analytical Mechanics," by Kurt Laves; "Notes"; and "New Publications."

THE November number of the *Bulletin* contains: Report of the twentieth summer meeting of the society, by H. E. Slaught; "Intuitionism and formalism," by L. E. J. Brouwer; "Shorter Notices": Arnoux's "Essai de Géométrie analytique modulaire à deux Dimensions," by L. E. Dickson; Padoa's "La Logique déductive dans sa dernière Phase de Développement," by J. B. Shaw; Hun and MacInnes's "Elements of Plane and Spherical Trigonometry," by Cora B. Hennel; "Notes"; and "New Publications."

THE articles in *The American Journal of Science* for November are as follows:

"Upper Devonian Delta of the Appalachian Geosyncline," by J. Barrell.

"Optical Bench for Elementary Work," by H. W. Farwell.

"Volcanic Research at Kilauea in the Summer of 1911," by F. A. Perret; with Report by A. Brun.

"Observations on the Stem Structure of *Psaronius Brasiliensis*," by O. A. Derby.

"Fauna of the Florissant (Colorado) Shales," by T. D. A. Cockerell.

"The Photoelectric Effect," by L. Page.

"Graphical Methods in Microscopical Petrography," by F. E. Wright. (With Plates II. to IX.)

"A Graphical Plot for Use in the Microscopical Determination of the Plagioclase Feldspars," by F. E. Wright.

"On the Influence of Alcohol and of Cane Sugar upon the Rate of Solution of Cadmium in Dissolved Iodine," by R. G. Van Name and D. U. Hill.

"Comparative Studies of Magnetic Phenomena. IV. Twist in Steel and Nickel Rods due to a Longitudinal Magnetic Field," by S. R. Williams.

A NOTE ON PENFOLD'S MODIFICATION OF BACILLUS COLI COMMUNIS[1]

PENFOLD'S[2] observation, that the cultivation of *Bacillus coli communis* upon monochloracetic acid media permits the selection of strains whose power to produce gas from certain sugars is permanently lost, has an important bearing not only upon mutation, but upon the mechanism of the carbohydrate metabolism of coliform organisms.

Through the work of Scruel,[3] Frankland and Frew,[4] Pakes and Jollyman,[5] Harden[6] and others, there has been gathered considerable evidence that the hydrogen and carbon dioxide, liberated in the fermentation of various sugars and allied compounds by coliform organisms, are the products of the decomposition of formic acid in accordance with the equation:

$$H_2CO_2 = H_2 + CO_2.$$

This decomposition has been attributed to the activity of a specific enzyme for which

[1] From the U. S. Department of Agriculture, Bureau of Animal Industry, Dairy Division.

[2] Penfold, W. J., *Proceedings of the Royal Society of Medicine*, Pathological Section, Vol. 4, Part 3, p. 97, 1910–11; *Journal of Hygiene*, Vol. II., p. 487, 1911.

[3] Scruel, *Arch. med. Belges*, ser. 3, t. 42, p. 362, 1892; ser. 4, t. 1, pp. 9 and 83, 1893.

[4] Frankland, Percy F., and Frew, William, *Journal of Chemical Society Transactions*, Vol. 61, p. 254, 1892, London.

[5] Pakes, Walter Charles Cross, and Jollyman, Walter Henry, *Journal of Chemical Society Transactions*, Vol. 79, Part 1, p. 386, 1901, London.

[6] Harden, Arthur, *Journal Chemical Society Transactions*, Vol. 79, Part 1, p. 610, 1901, London.

Franzen and Stuppuhn[7] have proposed the name formiase.

The important point in Harden's comparison of the products of fermentation of *Bacillus coli* and *Bacillus typhosus* lies in the fact that the products are very similar, with the exception that *typhosus* leaves considerable formic acid and no gas, while *coli* leaves little formic acid and produces considerable hydrogen and carbon dioxid. This suggests that an essential characteristic of *coli* and of similar gas-producing bacteria is their ability to elaborate the enzyme formiase. This enzyme was supposed to be active both in the gaseous fermentation of sugars and of the related alcohols.

Penfold's observation that by artificial selection a strain of *coli* may be isolated which retains its power to produce gas from certain alcohols while it has lost this power in its attack upon sugars, has therefore a profound theoretical significance.

In addition to this Penfold seems to have arrived at the conclusion that, if strains without the power to produce gas from sugars may be selected by artificial means, there is no certainty that they may not arise either in nature, or during ordinary laboratory cultivation, and so lessen the reliance which is to be placed upon the gas test in diagnosis. Indeed, if Penfold's conclusions are strictly interpreted, we are no longer able to attribute to an organism of the colon group, any characteristic which may be called a fundamental and immutable physiological function.

If the theory of natural selection in any of its original or modern forms is held applicable to bacteria, we must perhaps admit the probability that bacteria are subject to variation. That they do vary we will not dispute. That they may be made to undergo mutations, or that conditions may be imposed upon their growth in such a way that selection takes place in certain directions, we will not debate. We do insist, however, that before it is concluded that such mutations or selections have occurred in any specific instance, the analytical methods used to demonstrate these phenomena be methods of sufficient accuracy to establish confidence in the data.

While Penfold's conclusions may be in the main correct, there appear certain inaccuracies in his methods which detract from the confidence such important deductions should carry with them. We wish to call attention to these inaccuracies not so much as a polemic against Penfold, as a plea for greater care in the analytical procedures of bacteriological chemistry.

Penfold in his tests of gas production used the Durham tube. The Durham tube, while useful as a preliminary qualitative test for gas, is otherwise worthless. It is more inaccurate than the Smith tube, whose shortcomings were not only recognized by the originator, but more fully pointed out by Keyes.[8]

The gravest fault of each is the retention of a large proportion of CO_2 by the medium. Keyes's method of cultivating colon in vacuo, and pumping out the gas for careful analysis over mercury, seemed so promising that it was employed with certain modifications by Rogers, Clark and Davis[9] in their study of the gases produced by over 200 cultures of bacteria, among which those which we are justified in calling typical colons were abundant.

A remarkable constancy both in total amount of gas and in the ratio of the constituent gases produced by colon was demonstrated. Incident to this research, the gas production of a typical colon when grown on various media was studied. It was found that while the total amount of gas obtained after 7 days' incubation from 5 c.c. of a broth containing ½ per cent. K_2HPO_4 and 1 per cent. of sugar, was quite uniformly about 8 c.c., whether the sugar was dextrose or galactose, the total amount of gas obtainable from the same medium rose to 12 c.c. when dulcite or mannite was substituted for a hexose.

If we compare these results with the graphic representation of Penfold's determinations, on page 489 of his second article, we shall find

[7] Franzen and Stuppuhn, *Zt. f. Physiol. Chem.*, Vol. 77, p. 129, 1912.

[8] Keyes, *Journal of Medical Research*, Vol. 21, No. 1, p. 69, 1909.

[9] Rogers, L. A., Clark, Wm. Mansfield, and Davis, Brooke, paper about to be published.

some suggestive comparisons. In each set of results, the total gas produced by a *normal* colon from dextrose equals that from galactose, and the total gas from dulcite equals that from mannite. In each set, the total gas from dulcite and mannite exceeds that from galactose and dextrose. In our results, the total gas from the alcohols is one and one half times that from the sugars.

We have also found that the total gas produced by colon in a peptone water medium, such as Penfold used, is but little more than half that produced in our broth with phosphate.

With these facts in mind let us assume that we have to cultivate in peptone water a colon whose physiological powers are identical with those of a normal organism except that its activity has been greatly weakened. If it produces only enough gas from dextrose or galactose to saturate the medium, none will appear in a Durham tube, and it *might* be said that the gas-producing power was *nil*. If the same relative power to ferment alcohols that a normal organism possesses, is still preserved, the weakened organism might show some gas in a Durham tube in dulcite or mannite medium.

When grown in Durham tubes, Penfold's selected strain showed no gas in dextrose or galactose media, while it did in mannite and dulcite media. Our results show that a normal colon produces much more gas from these alcohols, and it may therefore be suspected that Penfold's strain shows gas from these alcohols and not from the sugars simply because it produces from the alcohols a sufficiently greater volume of gas to become manifest.

It is significant that Harden and Penfold[10] by applying the more exact method of Harden,[11] found that the selected organism instead of producing no gas from dextrose, as Penfold found by the Durham tube method, *does* produce both hydrogen and carbon dioxid. The ratio of these gases was not accurately determined, but the amount of hydrogen was found to be only 15 per cent. of that obtained from a normal colon. The other products, with the exception of lactic acid, were also greatly reduced.

Consequently, instead of concluding, as Penfold did, that his selected organism has had its power to produce gas from dextrose destroyed, and that its physiological characteristics have been qualitatively altered, we may just as reasonably conclude, so far as Penfold's original data are concerned, that the selected organism has merely been weakened. In addition to this it should be noted that Penfold has had difficulty in producing with *B. lactis aerogenes* modification similar to that obtained with *B. coli communis*. In view of this fact it may be illuminating to recall that Harden and Walpole[12] found that *B. lactis aerogenes* furnishes much more gas than does *B. coli* on the same medium.

If Penfold's culture is in this essential identical with that of Harden and Walpole, or with one of those organisms which Rogers, Clark and Davis have described as producing both more gas and a higher gas ratio than *B. coli*, then it may be that Penfold could not "suppress" the evolution of gas from his *lactis aerogenes* cultures, simply because he could not *weaken* it enough to prevent the formation of sufficient gas to more than saturate the medium; and not because it refused to undergo that fundamental "variation" which Penfold ascribes to *coli*.

It is of course impossible to make any accurate comparisons between our own exact determinations and those of Penfold, for the purpose of estimating the extent of his error. The unreliability and general inconstancy of gas determinations made with the Durham or Smith tubes is, or should be, universally recognized. Of special significance is the more recent work of Keyes and Gillespie[13] in demonstrating that in contrast to anaerobic growths there is a marked variation in the gas ratio of

10 Harden, Arthur, and Penford, W. J., *Proceedings Royal Society*, B. 85, p. 415, 1912.

11 Harden, Arthur, *London Journ. Chem. Soc.*, 1901, p. 610.

12 Harden, Arthur, and Walpole, *Proceedings Royal Society*, B. 77, p. 399, 1906.

13 Keyes and Gillepsie, *Journal Biological Chemistry*, Vol. 13, No. 3, p. 305, 1912.

aerobic cultures of *Bacillus coli*. This throws additional doubt upon the reliability of gas determinations made by the methods in common use.

Based largely upon his results with the Durham tube, Penfold at one time or another has come to the following conclusions:

> It may be suggested, therefore, that . . . the selective process has caused the removal of the formic-acid-forming ferment, but apparently has not interfered with the formic-acid splitting ferment.[14]
>
> The power of gas formation from sugars (always excepting isodulcite) may be lost when gas formation from alcohols is retained. It is probable, therefore, that two different ferments are engaged in the respective processes.[15]
>
> The research raises the question as to the weight to be attached to the power of fermenting glucose and lactose with gas formation in recognizing *B. coli* in routine examinations of pathological material, water, foods, etc. Hitherto, in all authoritative catalogues of the necessary properties of this organism, this has been included, but it probably ought not to be regarded as absolutely essential.[16]

Perhaps more exact work will demonstrate the essential truths there may be in these statements. If so, it will in no wise alter the contention of this article, which is that conclusions of such profound importance are worthy of being established by methods of reasonable accuracy.

It is gratifying to learn that Harden and Penfold have set out to do so. Pending the fuller publication of their results this article would not have been written but for the fact that Penfold since the publication of the preliminary report of Harden and Penfold, has published another paper,[17] in which he seems to have missed the *significance* of the discrepancy between his earlier statement that the variant colon produces no gas from dextrose, and Harden and Penfold's later statement that it does.

[14] Penfold, W. T., *Proceedings Royal Society of Medicine*, Pathological Section, Vol. 4, Part 3, p. 106.

[15] Penfold, W. T., *Journal of Hygiene*, Vol. II., p. 502.

[16] Penfold, W. T., *ibid.*

[17] *Journal of Hygiene*, April, 1913.

Unfortunately Penfold is not alone in the false confidence he has placed in the reliability of the Smith and Durham tube methods of bacterial gas determination. These instruments, which are useful only in the routine laboratory, are still being widely used in elaborate researches; and the time, therefore, seems ripe to emphasize the errors to which their use may lead, and to plead for greater accuracy in this important test of bacteriological chemistry.

WM. MANSFIELD CLARK

WASHINGTON, D. C.

SPECIAL ARTICLES

A NEW MEANS OF TRANSMITTING THE FOWL NEMATODE, HETERAKIS PERSPICILLUM

It has been found that *Heterakis perspicillum* may be transmitted to young chicks by a dung earthworm found in horse manure. The earthworm in question is probably *Helodrilus parvus* (Eisen).[1] The experiment demonstrating this relationship was performed during the past summer at the Kansas State Agricultural College. Eleven chicks, as soon as hatched, were placed in a fly-proof field cage and kept there until the close of the experiment. The cage was so constructed that the chicks could not reach chance insects that happened to light upon the outside screen. It had two fly-proof doors enclosing an entry way and the outer door was kept locked. When entering the cage the outer door was closed and the entry inspected for chance flies before opening the inner door. On leaving the pen the same care was taken. All chicks were thrifty and were fed upon the same ration of dry food to which was added twice per day some green alfalfa. It is needless to say that the alfalfa was always examined to prevent any insects from entering the pen. The earthworms were fed to three of the chicks. To the first chick a total of 78 worms was fed in lots of six to twelve each day between July 17 and July 26, inclusive. To the second chick 64 were fed, July 18 to July 29. The

[1] The earthworm mentioned has been referred to Professor Frank Smith, University of Illinois, for identification, and the nematode has been verified by Dr. Albert Hassell, Division of Zoology, B.A.I., Washington, D. C.

third chick received 53 worms between July 19 and July 28. When these chicks were killed September 5, twenty adult *Heterakis* were found in the first, six in the second and two in the third. Eight other chicks, from the same cage and killed at the same time, which had been kept under identical conditions, except that no earthworms were fed to them, did not show a single *Heterakis* present. There appears to be no escape from the conclusion that *Helodrilus* in some way may serve as an intermediate host for this nematode. The experiment does not show the nature of the transmission. Whether it is a case of true parasitism or is simply an association remains to be proved. It may be that the eggs of *Heterakis* simply cling to the more or less slimy surface of the earthworm and are transmitted in this way. Favoring this view is the probability that young chicks can become infected through eating eggs scattered in the feces of older chickens. However, the fact that small nematodes are frequently found in the nephridia of certain earthworms might furnish another suggestive hypothesis. Whatever the exact nature of transmission, the results are interesting. A hen and four young fowls, taken at random from the barnyard where the earthworms were found, were killed and examined for *Heterakis*. Nematodes were present in only two of these. Some of the fowls had the habit of going to the field instead of scratching and wallowing around the manure heap and this perhaps explains why more were not infected. Then the chances are small that any one chick would obtain a large number of earthworms, though the latter were only a short distance below the surface. In any case feeding *Helodrilus* under the conditions described was an efficient means of transmitting the *Heterakis* to young chicks.

JOHN W. SCOTT

UNIVERSITY OF WYOMING,
September 25, 1913

A NEW SPECIES OF MOROPUS (M. HOLLANDI) FROM THE BASE OF THE MIDDLE MIOCENE OF WESTERN NEBRASKA

WHILE studying the material representing the Chalicotheres in the Carnegie Museum in connection with the revision of the superfamily Chalicotheroidea, which is about to be published, the writer has found that a quantity of material representing a specimen from the Upper Harrison Beds of western Nebraska (Middle Miocene) is undoubtedly referable to a new species, which he desires to name in honor of Dr. W. J. Holland, the Director of the Carnegie Museum.

Moropus Hollandi sp. nov.

Type Specimen.—Radius, ulna, and portion of fore foot, femur, tibia, fragment of fibula, and portions of both hind feet. No. 1424. Carnegie Museum Collection. This material was discovered in 1901 and partially described by O. A. Peterson (*Ann. Car. Mus.,* Vol. IV., pp. 60–61, 1906) as *M. elatus.*

Specific Characters.—Limbs slenderer than in *M. elatus* Marsh or *M. petersoni* Holland. Third trochanter of femur somewhat less developed than in the latter species; facet for the trapezium on the scaphoid much reduced, or wanting; facet for trapezium on *Mc. II* wanting; metacarpals proportionally long and slender; proximal and median phalanges of second digit of manus more compressed laterally than in *M. elatus* or *M. petersoni.* The animal was larger than a tapir, but considerably smaller than *M. elatus* Marsh, which was as large as a rhinoceros.

A more detailed description of this species will appear in the work to which reference has been made, the first part of which has gone to the printer.

O. A. PETERSON

CARNEGIE MUSEUM,
October 8, 1913.

THE AMERICAN CHEMICAL SOCIETY

ROCHESTER MEETING

II

BIOLOGICAL CHEMISTRY SECTION

Carl L. Alsberg, *Chairman*
I. K. Phelps, *Secretary*

T. B. ALDRICH: ***On the Presence of Histidine-like Bodies in the Pituitary Gland (Posterior Lobe).*** (Preliminary communication.)

From the Research Laboratory of Parke, Davis & Co., Detroit, Mich. Employing Pauly's diazo-

benzene sulphonic acid reaction for the detection of histidine it seems probable that histidine or some form of it in a free state is contained in the desiccated posterior lobe of the pituitary gland, since by benzoylating direct, using Inouye's method Pauly's reaction was positive and that the body (or bodies) giving Pauly's reaction after hydrolysis by means of mineral acids or digesting with pancreatin is not tyrosine (which gives a similar reaction) since after benzoylating the histidine reaction still persists. Furthermore, the histidine-like body (or bodies) is probably not histidine, since it does not give Weidel's reaction as modified by Fischer or Knopp's reaction with bromine.

It would seem probable also that Pauly's reaction is not a specific reaction for histidine, but a reaction for certain bodies yet to be positively determined.

J. H. Long: *The Mutual Action of Pepsin and Trypsin.*

The older physiologists seem to have considered this a comparatively simple question, but their findings were not in agreement. Kühne was one of the first to discuss the problem and he concluded that pepsin destroys trypsin. This is probably correct, but his experimental evidence does not warrant the statement. In all such experiments the reaction of the medium must be pretty definitely known, as the content of hydrogen or hydroxyl ions is often the determining factor. In most of the older work these points were almost wholly overlooked, as the combining power of protein for acid or alkali was not known or not recognized. Making a due allowance for the reaction of the medium, the present experiments show that within the practical limits of body behavior trypsin has no important action on pepsin, while the action of pepsin on trypsin is markedly destructive, while an acid medium weakens the trypsin, pepsin plus acid seems to destroy it rather rapidly.

G. O. Higley: *A Further Study on the Well Water of Delaware, Ohio.*

The purpose of this study was to supplement that reported on at the spring meeting—to trace the relation between well water and an outbreak of typhoid. The city water had been examined and found safe. The water of about 100 wells has been analyzed and much of it found polluted. Five vaults were now selected in various parts of the city and in widely different soils: these were heavily salted and a weekly test for chlorides made during a period of nearly two months of the water of thirteen wells located from 58 to 118 feet from the vaults. Comparison of results of analyses made before and after the salting process, showed a decided increase in chlorides in well water at four of the five centers and in seven of the thirteen wells.

H. P. Armsby: *Comparison of the Observed and Computed Heat Production of Cattle.*

Jacob Rosenbloom and S. Roy Mills: *The Non-interference of Ptomaines with Certain Tests for Morphine.*

We have determined experimentally that bacterial products formed during aerobic and anaerobic putrefaction of various human organs do not give reactions simulating those due to the presence of morphine and in no way do they interfere with the detection of morphine when added to these putrefactive products.

Jacob Rosenbloom: *On the Distribution of Mercury Following Acute Bichloride of Mercury Poisoning.*

The writer has estimated the amount of mercury in the organs of a woman who died eight days after ingestion of bichloride of mercury.

James P. Atkinson: *The Effect of Electrolysis on Whole Proteins, Witte's Peptone, and some of their Decomposition Products.*

Whole protein (egg white), Witte's peptone and protein (horse serum), hydrolyzed by hydrochloric acid, yield approximately 50 per cent. of the total nitrogen as ammonia when electrolyzed in a sulphuric-acid solution. The amino acids tested, glycylglycine, uric acid and urea, do not yield as much nitrogen as ammonia under the same conditions, while ammonium sulphate is unaffected.

A. F. Blakeslee and R. A. Gortner: *The Non-development of Cytolytic Sera following the Intravenous Injection of Mould Spores.*

Intravenous injections of the spores of each race of Mucor "V" were given to rabbits, rabbit No. 5 receiving 30 injections of the ♂ race and rabbit No. 55 receiving 29 injections of the ♀ race. Each injection would average about 500,000,000 spores. Following the last injection of approximately 800,000,000 spores a loop of blood was taken at intervals of 30 minutes for 6 hours, then every hour for 4 hours more, then every two hours for 16 hours more and later at less frequent intervals. Separation cultures were made of agar which contained the loop of blood taken and the number of mould colonies which developed were counted. A similar test was made at the same time, using rabbits which had received their first injection of the spores. In each case the disappearance of the

spores occurred after about 43 hours, the immunized rabbits retaining the viable spores as long as the check rabbits.

R. A. GORTNER and A. F. BLAKESLEE: *The Occurrence of a Toxin in the Bread Mould, Rhizopus nigricans.*

We have found that there is a toxin in the bread mould which, when administered intravenously to rabbits, causes their death with all of the symptoms of anaphylaxis. The toxin is stable to peptic digestion and to heating at 100° for five minutes. The toxin, as prepared, is present in the mould to about 4 per cent., is soluble in water, from which solution it may be precipitated by alcohol, and is non-dialyzable. The lethal dose for rabbits, when given intravenously, is about 1:225,000 parts of body weight.

RAY E. NEIDIG: *Effect of Acids Upon the Catalase of Taka-diastase.*

Data were presented showing the inhibiting effect of several of the important inorganic and organic acids toward catalase of taka-diastase. Curves were plotted for different acid concentrations which show the quantity of oxygen liberated at stated intervals. The acids, arranged in order of the magnitude of their inhibiting effect for equinormal solutions, are as follows: sulphuric, hydrochloric, oxalic, tartaric, citric and acetic. The inhibiting effect of the first three was much more pronounced than that of the others. Neutralization of the acid solution usually restored some of the activity, the amount of increase depending upon the particular acid used. Van Slyke's amino-nitrogen apparatus was used in these experiments for measuring the amount of oxygen liberated.

RAY E. NEIDIG: *Polyatomic Alcohols as Sources of Carbon for Molds.*

A comparison of some of the polyatomic alcohols occurring in nature was undertaken in order to determine the degree of their utilization by molds as sole sources of carbon. The alcohols used were methyl alcohol, glycol, glycerol, erythrite, adonite, mannite, dulcite and sorbite. Eight species of molds representing four genera were cultivated in media containing these alcohols.

It was found that methyl alcohol produced no growth, glycol induced germination only, glycerol produced strong cultures, erythrite could be used by the majority of molds and adonite by only a few, while all three of the hexatomic alcohols may be regarded as good sources of carbon. These results indicate that molds are able to use both optically active and inactive compounds as sources of carbon. If viewed from the standpoint of their oxidation products it is possible that active compounds are first formed and these are then utilized in the development of the molds.

ARTHUR W. DOX and W. E. RUTH: *Cleavage of Benzoylalanine by Mold Enzymes.*

Continuing our studies on the enzymic cleavage of glycocoll derivatives by means of the formol-titrimetric method, a homologue of hippuric acid, viz., benzoylalanine, was tested. Seven species of the lower fungi were found to produce an enzyme capable of decomposing *dl*-benzoylalanine to the extent of 12.8 per cent. to 24.5 per cent. in two weeks.

F. C. COOK: *The Importance of Food Accessories as shown by Rat-feeding Experiments.*

Most of the twelve white rats fed on a basal diet of protein, fat, carbohydrates and salts for eighty days lost weight during the last three weeks. For thirty-five days immediately following, 5 c.c. of meat extract, plant extract solution or milk were alternately added to the basal diet, the nitrogen and sodium chloride being equal. Milk and meat extract stimulated growth, plant extract showed little stimulating power. Eleven young white rats fed for thirty-five days on the basal diet, plus one of the three accessories, showed similar results. Milk, also meat extract, gave the biuret reaction and precipitates with phosphotungstic acid. Plant extract gave neither. Meat extract is a hydrolyzed product practically free from fat and carbohydrates. The rats gained more on a smaller number of calories when milk or meat extract was ingested than when fed on the basal diet alone.

CHRISTINE CHAPMAN and W. C. ETHERIDGE: *Influence of Certain Organic Substances Upon the Secretion of Diastase by Various Fungi.*

In this work the influence of varying concentration of cane sugar, glucose, peptone and tannic acid upon the secretion of diastase by *Aspergillus niger, Aspergillus Oryzæ, Penicillium expansum, Penicillium camembertii, Mucor Rouxii* and *Cephalothecium roseum* has been investigated. Czapek's solution was employed with the sugar replaced by 0.4 per cent. soluble starch. To this was added the quantity substance whose influence was to be determined. It was found in general that the presence of any of the above organic substances retarded the secretion of diastase by the fungi mentioned. The higher the concentration the greater the retardation.

H. H. BUNZEL: *The Rôle of Oxidases in the Curly Dwarf Disease of Potatoes.*

Oliver E. Closson: *A Time Recorder for Kymograph Tracings.*

It is at best a tedious operation to find the projection of the time record on the different graphs as ordinarily traced upon smoked paper.

By the following simple device the time interval can easily be recorded by a fine line, entirely across the paper.

A fine spring wire stretched two to three millimeters from the smoked surface will, when picked by the armature of the time signal magnet, strike the smoked paper on the rebound and remove a fine line of soot.

By a little adjusting a single distinct line is recorded at each closure of the circuit. If it is inconvenient to adjust any recorder to write perpendicular to the base line it is a simple matter to adjust so that the time line is parallel to any such line.

Oliver E. Closson: *Apparatus for Studying Oxidases.*

The reaction of oxidases with hydrogen peroxide liberates heat, and the temperature factor being large as well as the expansion of the gas, all necessitate a thermostat control and continued agitation of the mixture for comparative studies.

To obtain uniform temperature and continuous record of the liberated gas the following apparatus was devised.

A shaking member with two compartments, one for holding the hydrogen peroxide and the other for the enzyme solution, is connected by a tube with ground joint to a large cylindrical container with center at the axis of motion so that liquid in this container is not agitated by motion around the axis. This arrangement allows the shaking of the reacting solution and the measure of the liberated oxygen by the water displaced.

The large container has a tube extending along the axis to the outside of the thermostat, which allows the discharge of the displaced water into a vessel suspended by a spring, so that a writing arm can be made to record the volume, giving on a rotating drum a curve, which can be analyzed at one's leisure.

Amos W. Peters and Mary E. Turnbull: *A Method for Studying Slight Degrees of Glycosuria, Adapted from Macleod and S. R. Benedict.*

Urine is clarified by the method of Macleod, *i. e.*, urine + concentrated acetic acid + Merck's blood charcoal. No sugar is lost by this procedure, the urine is diluted to only 7/5 original volume, the filtrate is water-clear for polarization. Five c.c. of the filtrate, contained in a 100 c.c. Kjeldahl flask, is neutralized with saturated solution of Na_2CO_3, using alizarine, and 5 c.c. of a modified Benedict reagent is added. After placing a pebble in the liquid and fixing the flask in an inclined position directly over a small Bunsen flame the whole is boiled for 2½ minutes. The resulting small volume is transferred to a centrifuge tube and made to 10 c.c. Examined under a shaded electric light and against a dark background even a trace of dextrose shows turbidity, and after centrifugation so little as 0.0035 per cent. shows a film of red precipitate. Quantitative estimations are made by comparison with standards based upon a normal urine obtained under normal diet and showing zero rotation, or nearly so, after clarification, and to which dextrose is added in steps of 0.01 per cent. The sensitivity is such that pronounced differences result with these small intervals.

Composition of the above reagent: Sod. citrate 100 gm.; sod. acetate 100 gm.; sod. carb. anhyd. 50 gm.; cryst. copper sulph. (Kahlbaum) 12.5 gm.; dist. water add 500 c.c.

W. S. Hubbard and D. M. Cowie: *A Method of Estimating Fat in Infant Stools.*

S. L. Jodidi: *Nature of Humus and its Relation to Plant Life.*

Philip Adolph Kober: *The Estimation of Protein, Animo and Nucleic Acids in Potable Waters.*

William N. Berg: *Surface Tension in Muscle Contraction.*

Macallum quotes Jensen to the effect that "a thread measuring 1 millimeter in diameter formed of the plasmodium of *Chondrioderma*, a Myxomycete, may, when it is in the dense condition, bear up a weight of nearly a gram. If the force engaged is surface tension it would amount to about 6,000 dynes per centimeter."

At the same time Macallum does not quote Pfeffer, who says that in the case of the plasmodium of *Chondrioderma*, the outer membrane may vary reversibly, in its consistency, from that of the fluid protoplasm in the interior of the cell to that of solid gelatinous masses.

Jensen obtained the figure of 6,000 dynes per centimeter by dividing the weight sustained by the plasmodium thread by the circumference of the thread. It would have been just as logical to divide the weight sustained by a steel wire by the circumference of the wire and call the equipment the surface tension of steel.

C. S. Hudson and T. S. Harding: *The Estimation of Raffinose by a Modified Biological Method.*

William Salant and J. B. Rieger: *The Elimination of Zinc.*

The experiments were made on rabbits. Zinc was given intravenously and zinc acetate subcutaneously. The urine collected for period of 24–48 hours showed the presence of 1–2 milligrams of zinc. Much larger amounts were found in the feces and contents of the gastro-intestinal canal after the subcutaneous injections. The quantities of zinc varied between 8.5 and 17.1 milligrams in 24–48 hours, which represented 10–34 per cent. of the amounts introduced. The amounts of zinc eliminated by this channel were greater after intravenous injection, being 17–20 milligrams, or 40 per cent. of the quantity administered.

William Salant and L. P. Treuthardt: *The Absorption and Fate of Tin in the Body.*

Tin in the form of a double salt was given subcutaneously and by mouth to different animals. Analyses of the urine and feces, contents of the stomach and intestines, which were made gravimetrically and volumetrically, gave the following results: After the subcutaneous administration 5–15 per cent. was eliminated in the urine in 24–48 hours. The feces of the corresponding period contained much smaller amounts. The contents of the stomach and intestines and the feces contained as much or more tin than the urine. In some animals the amount of tin eliminated by the kidneys was smaller than that recovered from the gastrointestinal contents and feces.

Analysis of the skin indicated the presence of 20–25 per cent. of the amount of tin injected.

When double salts of tin were given by mouth, small quantities of it were found in the tissues and in the urine, indicating that absorption from the gastrointestinal canal takes place to a very small extent only and may be insignificant in some animals.

The amount of tin found in the liver of rabbits at the end of 48 hours varied between 0.6 per cent. and 10.8 per cent. The kidneys of such animals contained quantities varying between 1.6 and 8.2 per cent. of the amount of tin injected. Experiments on the absorption of salt from the blood indicate that 85–95 per cent. may disappear in 2–3 hours after the intravenous injection of 70–200 milligrams tin.

Donald D. Van Slyke and Gustave M. Meyer: *The Fate of Protein Digestion Products in the Body.*

Previous work by the authors has shown that during digestion amino acids are absorbed into the blood, as the amino acid nitrogen of the latter per 100 c.c. rises, in a dog, from 4–5 mg. before feeding to 10–12 mg. after a meal of meat. The low concentration of amino acids in the blood even at its maximum indicates that the digestive products must be removed rapidly from the circulation. This is found to be the case after the injection of amino acids directly into the circulation. They disappear from the blood almost as fast as they enter it. Analysis of the tissue shows that these have absorbed the amino acids from the blood, without subjecting them to any immediate chemical change. This apparently follows later, but in the muscles is so slow that no decrease in amino acid nitrogen can be determined within the first 3–4 hours after the injection. In the liver, on the other hand, the amino acids absorbed as the result of the injection have entirely disappeared in this time, indicating that the metabolism of these products is particularly rapid in the liver. It is less so in the other organs, but whether as sluggish as in the muscles is not yet certain. During starvation the amino nitrogen of the tissues, which amounts to 40–80 mg. per 100 gm. of fresh tissue, tends to increase rather than disappear, indicating that the amino acids of the tissues can originate from autolysis of the tissues themselves as well as from digestion of food proteins.

George Peirce: *The Configuration of Some Heptoses.*

d-α-mannohexahydroxyheptoric acid and *d*-α-galahexahydroxyheptoric acid yield on oxidation two pentahydroxykinetic acids that are optical antipodes of each other. The configuration of four of the asymmetric carbon atoms in each monobasic acid is known and the configuration of the fifth is given by the above fact. The corresponding heptites are also optical antipodes.

CO_2H	CO_2H	CO_2H	CO_2H
HCOH	HOCH	HOCH	HCOH
HOCH	HOCH	HOCH	HOCH
HOCH	HOCH	HCOH	HCOH
HCOH	HCOH	HCOH	HCOH
HCOH	HCOH	HOCH	HOCH
CH_2OH	CH_2OH	CH_2OH	CH_2OH
I.	II.	III.	IV.
From *d*-mannose.		From *d*-galactose.	

Of the following four configurations I. and III. are seen to be the two that give optical antipodes on oxidation or reduction of the end carbon atoms. These two are, therefore, the formulæ for the α compounds. The β galactose compounds of

formula IV. have been synthetized. The β mannose compounds of formula II. have not yet been prepared.

M. X. Sullivan: *Some Organic Constituents of the Culture Solution and the Mycelium of Molds from Soil.*

Examination was made of the dried mycelium of mixed mold cultures from soil and of *Penicillium glaucum* grown on Raulin's solution and of the filtered solution after mold growth for organic constituents. In the mixed molds was found a large number of organic substances, many of which were subsequently found in *Penicillium glaucum*. In the alcoholic soda extract of *Penicillium glaucum* were found oleic and palmitic acids, a fatty acid melting at 54° C., a fatty acid which appears to be elaidic acid, hypoxanthine, guanine and adenine, histidine, thymine and chlorine. In the direct alcohol extract was found mannite, cholesterol bodies, hypoxanthine and cerebrosides. From mold grown on Raulin's solution plus peptone a small amount of guanidine was found. In the culture solution after a number of weeks' growth were found fatty acids, purine bases, a small quantity of a histidine-like body, pentose sugar, unidentified aldehydes, etc. Many of these compounds have been found in soil and the conclusion is drawn that microorganisms, such as yeasts, bacteria and molds, play an important part in their formation.

M. X. Sullivan: *Vanillin in Wheat and its Relation to Soil.*

By means of the sodium bisulphite aldehyde method, an aldehyde smelling like vanillin and giving vanillin color reactions was found in the alcohol and ether extracts of ungerminated wheat seeds, in the roots, seeds and tops, respectively, of young wheat seedlings in rotten wood, and in the water in which wheat had germinated and grown. Estimated quantitatively by Folin and Denis's colorimetric method, the amount in the ungerminated seed is small, several parts per million, but is considerably increased during germination and the early stages of growth. Treating the seed with 5 per cent. sulphuric acid also increased the amount of vanillin extractable. The presence of vanillin in other plants was indicated. The vanillin of soil undoubtedly has its origin in part in vegetable débris and plant.

W. R. Bloor: *A Method for the Determination of Small Amounts of Fat.* (Preliminary report.)

The method consists essentially in extracting the fat from the tissue or liquid with an excess of alcohol-ether (25 per cent. ether), measuring an aliquot portion of the filtered extract into distilled water and determining the amount of fat by comparison of the cloudy suspension so obtained with a standard fat solution by the use of the nephelometer. The method has given good results with blood and milk.

C. G. MacArthur and G. Norbury: *Nitrogenous Hydrolysis Products of Several Phosphatids.*

Sheep brain kephalin, sheep brain lecithin, ox heart cuorin and ox heart lecithin were prepared, purified and then hydrolyzed in a dilute hydrochloric acid solution. In each case the fatty acid residue contained nitrogen, usually about one sixth of the total. The filtrate nitrogen was separated by a special method into four fractions, representing (1) ammonia, (2) chlorine or other basic compound, (3) amino acid, or compounds not precipitated by platinum chloride but precipitated by mercuric acetate in a sodium carbonate solution, and (4) the filtrate from (3). The two lecithins contain about two fifths of the nitrogen in the form (2), while kephalin and cuorin contain practically none. In all of them, fraction (3) is large, varying from one third to one half.

L. V. Burton and C. G. MacArthur: *Fatty Acids from Kephalin.*

The fatty acids obtained from hydrolyzing purified kephalin in a dilute hydrochloric acid solution were separated by the lead acetate method into the saturated and unsaturated fatty acids. The saturated acid fraction represented about one third of the total and was found to contain stearic and palmitic in the ratio of three to one. The unsaturated fatty acids were separated by the bromination method into clupanodenic acid, linolic acid and oleic acid. The amount of clupanodenic acid present was small, less than 2 per cent. The linolic acid was found to represent about one sixth of the total fatty acids. Oleic acid comprised about one third of the total.

E. B. Forbes: *A Metabolism Experiment with Swine.*

The usual practical rations for swine contain an excess of acid over basic mineral elements. Urinary ammonia varies directly with this excess of mineral acid, provided the protein intake remains the same. Increased protein intake increases urinary ammonia. This excess of mineral acid in practical swine rations seems not to affect calcium retention.

Water-drinking caused the elimination of sodium and chlorine; abstinence from drinking leads

to their retention. The feces may contain an abundance of sodium, but are nearly free from chlorine.

Potassium, magnesium and chlorine balances were usually positive, but were negative during periods of maximum intake, apparently through over-response in the way of protective elimination of excess ingested.

Calcium retention was satisfactory only on rations containing meat meal containing considerable bone and skim milk. Neither cereals nor soy beans furnish the calcium requisite for growth.

An excess of magnesium to calcium caused loss of calcium with a ration of rice polish and wheat bran. The excess of magnesium to calcium in corn and in other practical rations does not appreciably restrict calcium retention.

The important deficiencies of corn are, in order of magnitude, first, calcium; second, phosphorus; third, nitrogen.

Creatinin elimination was entirely independent of food, but varied in the same order as live weight, weight of dressed carcass, of flesh, of bones and of blood.

Soy beans, meat meal and skim milk increase the digestibility of the carbohydrates of the corn with which they are fed. Meat meal and skim milk increase the apparent digestibility of the fat, and decrease the digestibility of the crude fiber of the corn with which they are fed, the results being digestion coefficients of more than 100 and less than nothing.

V. C. MYERS and M. S. FINE: *The Fate of Creatine and Creatinine when Administered to Rabbits.*

When creatine is administered subcutaneously to rabbits in amounts varying between 50 and 100 mgm. per kgm. of body weight per day, 25–80 per cent., depending upon the amount given, reappears in the urine unchanged, 2–10 per cent. is eliminated as creatinine, about 15 per cent. is retained by the muscle, while, if introduced in small amounts, as much as 50 per cent. may be metabolized. We are inclined to attach considerable significance to the slightly increased excretion of creatinine as indicating the metabolic relationship between these two substances. The creatine content of the muscle was raised from the normal of 0.52 per cent. to 0.55 per cent. (5 expts.) after the administration of creatine, and to 0.56 per cent. (3 expts.) after the administration of creatinine.

ANDREW HUNTER, M. H. GIVENS and C. M. GUION: *Studies in the Comparative Physiology of Purine Metabolism.*

PHILIP ADOLPH KOBER: *The Estimation of Protein, Amino and Nucleic Acids in Potable Waters.*

Experiments show that by using the right precipitants and evaporating to one tenth of the original volume proteins and nucleic acids can be estimated in potable waters by the author's nephelometric method. This method will easily reveal the presence of one part of substance in one million parts of water.

By using the copper method (to be described by the author in the next number of the *Journal of the American Chemical Society*) potable waters may be analyzed for amino acid nitrogen before or after hydrolysis. This method will reveal one part of amino acid nitrogen in one million of water, without difficulty.

HOWARD D. HASKINS: *The Acidity of Normal Urine.*

Certain modifications of Henderson's method were suggested. Permanent color standards were proposed for the range of acidity determined by paranitrophenol. A report was made of a study of variations of acidity in 24-hour samples and in fractional samples, *i. e.*, the day's urine collected in five periods. No relation of concentration of urine to acidity was found. The effect of diet was slight. Night urine was distinctly acid in 50 per cent. of the cases, and morning urine (breakfast to 11) was of very low acidity in 50 per cent. of the cases. Sweating seemed to have a marked effect in causing higher acidity.

MAX KAHN: *Metabolism Studies of Five Cases of Endarteritis obliterans.*

Five patients suffering from obliterating endarteritis were fed on a Folin diet and their metabolism studied. It was found that the nitrogen metabolism was normal but that the calcium and ethereal sulfates were increased in the urine.

MAX KAHN: *Calcium Content of Tuberculous Areas in Lung Tissue.*

Wherever the tubercle bacillus lodges it induces a deposition of calcium salts which hinders the ingress of more tubercle bacilli. The body in general becomes poorer in lime salts. It was found that tubercular areas in the lungs contained two to three times as much calcium as normal lung tissue. The work is in progress.

MAX KAHN and A. HYMANSON: *Metabolism Studies of Two Cases of Amaurotic Idiocy.*

Two cases of amaurotic family idiocy were kept under observation until death. The metabolism of nitrogen, sulfur and phosphorus was carefully

studied. It was found that both retention and absorption were normal or above normal. The digestive system does not seem to be at all deranged in this fatal disease.

T. L. Harkey: *Further Studies of Edema.*

Olive G. Patterson: *A Study of the Influence of External Hemorrhages on the Partition of Urinary Nitrogen.*

Victor E. Levine: *Biochemical Studies of Selenium.*

Benjamin Horowitz and W. J. Gies: *Pigments Produced from Thymol by Ammonium Hydroxide.*

Louis Berman and W. J. Gies: *A Differential Stain for Mucine and Mucoids.*

Max Kahn and W. J. Gies: *The Origin and Significance of Salivary Sulfocyanate.*

A. P. Lothrop and W. J. Gies: *Biochemical Studies of Dental Caries.*

W. J. Gies: *Further Studies of the Permeability of Lipin-Collodion Membranes.*

W. D. Bancroft: *Light and Health.*

(*To be concluded.*)

Charles L. Parsons,
Secretary

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and sixty-fifth regular meeting of the society was held at Columbia University on Saturday, October 25, extending through the usual morning and afternoon sessions. Thirty-three members were in attendance. President E. B. Van Vleck occupied the chair, being relieved by Professor H. S. White. The following new members were elected: R. W. Burgess, Cornell University; Tomlinson Fort, University of Michigan; Cora B. Hennel, Indiana University; Arthur Korn, Charlottenburg, Germany; J. H. Kindle, University of Cincinnati; M. A. Linton, Provident Life and Trust Company, Philadelphia; John McDonnell, Geodetic Survey of Canada; J. Q. McNatt, Colorado Fuel and Iron Company; T. E. Mason, Indiana University; B. E. Mitchell, Columbia University; George Paaswell, New York City; D. M. Smith, Georgia School of Technology; Panaiotis Zervos, University of Athens. Twelve applications for membership were received.

The meetings of the Chicago Section having been for some years of equal importance with the meetings held in New York and technically described as meetings of the society, it has been decided to obliterate this outgrown distinction by making the Chicago meetings also regular meetings of the society, so far as the presentation of scientific papers is concerned. The society will hereafter enjoy a possibly unique distinction, in that it will hold practically simultaneous meetings in two cities.

Following closely on the volume of the Princeton Colloquium Lectures, the society will shortly publish the Madison Colloquium Lectures of Professors L. E. Dickson and W. F. Osgood. This will be Volume IV. of the series of Colloquium volumes, its predecessors being the Boston, New Haven and Princeton Lectures.

It was decided to hold the summer meeting of 1914 at Brown University, in acceptance of the invitation by that university to participate in the celebration of its one hundred and fiftieth anniversary.

The following papers were read at the October meeting:

G. M. Green: "Projective differential geometry of one-parameter families of space curves, and conjugate nets on a curved surface."

G. M. Green: "One-parameter families of curves in the plane."

Edward Kasner: "The classification of analytic curves in conformal geometry."

G. H. Graves: "Systems of algebraic curves of least order for genera 3 and 4."

A. A. Bennett: "Quadri-quadric transformations."

A. A. Bennett: "A set of postulates for a general field admitting addition, multiplication, and an operation of the third grade."

T. H. Gronwall: "On analytic functions of several variables."

H. Galajikian: "Concerning the continuity and derivatives of the solution of a certain non-linear integral equation."

G. M. Green: "On the limit of the ratio of arc to chord at a point of a real curve."

W. H. Roever: "Geometric derivation of a formula for the southerly deviation of falling bodies."

The San Francisco Section held a meeting also on October 25. The Southwestern Section will meet at the University of Missouri on November 29. The society will meet in Chicago on December 26–27, and will hold its annual meeting in New York on December 30–31. At the latter meeting Professor H. B. Fine will deliver his presidential address on "An unpublished theorem of Kronecker respecting numerical equations."

F. N. Cole,
Secretary

SCIENCE

FRIDAY, NOVEMBER 14, 1913

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

NATIONAL ACADEMIES AND THE PROGRESS OF RESEARCH

I. THE WORK OF EUROPEAN ACADEMIES

THE Academy of Plato, who bequeathed to his followers the walled garden and appointments in the place named after the hero Hekademus, was at once a school of instruction and a society for the development of new knowledge. Here he discussed his philosophy with associates and students, while it was still in the making, thus bringing them under the stimulating influence of fresh thought, developing and expanding from day to day. Writing of the Old Academy, which included the schools of Plato and his immediate successors, Cicero remarks:

> Their writings and method contain all liberal learning, all history, all polite discourse; and besides they embrace such a variety of arts, that no one can undertake any noble career without their aid. . . . In a word the academy is, as it were, the workshop of every artist.[1]

The Old Academy was thus the predecessor of our modern academies of science and of our universities as well. Its worldwide influence, while of course primarily due to the brilliant thinkers of the day, may certainly be ascribed in part to the fact that its instruction was given in an atmosphere charged with the stimulus of original thought and constantly broadening ideas. The great success of the German universities, and the outflow from them of the spirit of research into every phase of German life and thought, is undoubtedly due in the largest measure to the application of this principle. Fortunately for the intel-

[1] Cicero, "De Fin.," Vol. 3, as quoted in the Encyclopædia Britannica, 11th edition, Vol. 1, p. 106.

lectual advancement of the United States, the recognition of its importance has already permeated most of our advanced schools, and is rapidly gaining ground in the minds of their governing boards of trustees.

Aristotle, called by Plato "the mind of my school," came from a family of physicians, and thus inherited a taste for experimental knowledge. To him we owe the beginnings of exact science and the organization of research on a large scale. Thanks to his influence with his pupil Alexander the Great, he was able to command the immense sum of eight hundred talents for the purchase of books and other expenses involved in the preparation of his treatise on zoology. More than this, a thousand men throughout Asia and Greece studied under his direction the life and habits of birds and beasts, fishes and insects.[2] The territories conquered by Alexander were carefully surveyed, by measuring the position of terrestrial objects with respect to stars.[3] Although Aristotle maintained the fixity of the earth, and supposed comets and the Milky Way to be in its higher atmosphere, his reasoning in many astronomical problems was sound, as when he concluded that the earth must be spherical because its shadow on the eclipsed moon is always curved.[4] Thus his studies of natural science foreshadowed the work of the present-day investigator and led to the most far-reaching results.

After his time a gradual division of labor ultimately separated investigations in natural science from the speculations of the philosophers. In Sicily, Egypt and the islands of the Mediterranean true scientific research, in the strictly modern sense, developed with remarkable rapidity, while in the old Lyceum at Athens the philosophy of reasoning and dialectics, caring little for physical causes, was devoted exclusively to the soul.

A deep-seated belief that the senses are deceptive, and the natural impatience of the Greeks, inclining them toward reasoning and speculation rather than the slow and laborious processes of observation and experiment, had first to be overcome.[5] But in the third century B.C. the greatest geometer of antiquity, Archimedes, taught at Syracuse a system of astronomy closely resembling that of Copernicus, founded the science of mechanics in his treatise "De Æquiponderantibus," and devised some of the fundamental experimental methods of modern physics. At the same period Aristarchus of Samos made a first determination of the distance of the sun from the earth and held that "the center of the universe was occupied by the sun, which was immovable, like other stars, while the earth revolved around it."[6] This view was also taught by Seleucus the Babylonian, but it was rejected by Ptolemy, the most celebrated astronomer of his day.

Of all the ancient prototypes of the modern academy, the great Museum of Alexandria holds the first place. Founded by Ptolemy Soter, whose preference would have confined its work to the moral and political sciences, its scope soon expanded under the influence of Ptolemy Phila-

[2] Wheeler, "Alexander the Great," p. 37. The strict accuracy of these assertions, which were made by several classical authors, is questioned by Grote and also by Humboldt, who nevertheless concede that Aristotle received from both Philip and Alexander the most liberal support in procuring immense zoological material from Grecian territories and in the collection of books. "Cosmos," Sabine's trans., Vol. II., p. 158.

[3] Bossut, "Histoire des Mathématiques," Vol. 1, p. 116.

[4] *Ibid.*, p. 117.

[5] Weber, "History of Philosophy," Thilly's trans., p. 133 *et seq.*

[6] See Humboldt, "Cosmos," Vol. II., p. 309, and notes, p. cix.

delphus and the pressure of circumstances, until it embraced the whole field of knowledge.[7] Here almost all of the important results of Greek science were obtained in a period covering nine centuries. The museum established by Ptolemy was an extensive palace, housing the brilliant company of scholars and investigators gathered together from all parts of Greece. As a state institution, endowed with special revenues, it was under the direction of the government, which appointed its head. This, in accordance with the traditions of the day, was a priest, whose ecclesiastical office, and even the name of the museum itself, gave a kind of religious character to the institution,[8] though it subsequently became purely secular.

Ptolemy Philadelphus collected strange animals from many lands, and sent Dionysius on exploring expeditions to the most remote regions.[9] But while the investigators of the museum doubtless profited by these collections and explorations for their studies in natural history and geography, Matter finds no evidence that at this period the museum possessed either a distinct natural history collection or a zoological park,[10] though the study of medicine was encouraged, and a great art collection was developed.

The rising tide of science soon brought all the material requisites of research, supplementing the great library of 700,000 volumes by the instruments, laboratories and collections demanded by the astronomer, the physicist and the student of biology. A botanical garden, a zoological menagerie, an anatomical laboratory and an astronomical observatory in the Square Porch, provided by Ptolemy Euergetes with an equinoctial and a solstitial armillary, stone quadrants, astrolabes and other instruments, illustrate the nature of the extensive equipment provided. The work of the Alexandrian school thus continued to grow, until it embraced all of natural and physical science, medicine, mathematics, astronomy and geography, history, philosophy, religion, morals and politics. It is significant that an institution which in many respects would be regarded as a model to be striven for to-day, should have developed at so early a period in the history of civilization.[11]

To the Alexandrian school we owe the "Geometry" of Euclid, and his treatises on "Harmony," "Optics" and "Catoptrics"; the hydraulic screw and some of the mathematical and physical discoveries of Archimedes of Syracuse, who spent part of his time in Egypt; the mathematical, astronomical, geographical and historical investigations of Eratosthenes, who first endeavored to determine the circumference of the earth by measuring the difference of latitude and the distance between Alexandria and Syene, and wrote on such subjects as the geological submersion of lands, the elevation of ancient sea-beds, and the opening of the Dardanelles and the Straits of Gibraltar; the "Conic Sections" of Apollonius; the mathematical and astronomical researches of Hipparchus, whose discovery of the precession of the equinoxes was based on observations made five hundred years previously by Timochares at Alexandria; and the great "Syntaxis" of Ptolemy, translated as the "Almagest" by the Arabians, which stood as a commanding authority in Europe for nearly fifteen hundred years. Founded on the geocentric hypothesis, the "Almagest" is nevertheless

[7] Matter, "Histoire de l'Ecole d'Alexandrie," 2d ed., Vol. II., Introduction, p. v.

[8] *Op. cit.*, Vol. I., pp. 87 and 96.

[9] *Ibid.*, p. 158.

[10] *Ibid.*, p. 159.

[11] Draper, "Intellectual Development of Europe," Vol. I., p. 188.

replete with astronomical methods and observations of the widest range and significance, and includes Ptolemy's discovery of the lunar evection, a rough determination of the distance from the earth to the sun, a masterly discussion of the motions of the planets, and a catalogue of 1,022 stars. These remarkable advances, which include only a fraction of the enormous scientific product of the Alexandrian school, were supplemented by equally striking contributions to literature and art. Philology, criticism and the history of literature became sciences, while the coming together of Buddhists, Jews, Greeks and Egyptians, with the most diverse beliefs, led to the development of comparative theology. Of the literary works of the Alexandrian school the Septuagint and the poems of Theocritus are perhaps the most widely known.[12]

The rising power of Rome, which finally made of Alexandria a mere provincial town, was coincident with the decline of Greek intellectual life. In this paper only the more significant epochs in the development of academies can be mentioned, and we must pass over the work of the immediate successors of the Alexandrian school in Rome and Byzantium, and the achievements of Arabian science in Africa, Spain and Persia. In 1453, by the fall of Constantinople, where Greek scholars had preserved, in antiquated and pedantic form, the literary and philosophical traditions of the Alexandrian age, Italy was once more raised to its old position of "Magna Græcia." Some years earlier the scholar and ambassador Pletho, aided by Cosimo de Medici, had established a Platonic academy in Florence. Under this stimulus, and the influence of the Greek refugees, philosophy became popular, and Greek was widely studied. The voyages of Columbus, Da Gama and Magellan, and the astronomical achievements of Tycho Brahe, Copernicus, Kepler and Galileo reawakened the appreciation of scientific research and its possibilities. Leonardo da Vinci continued the work of Archimedes and the Alexandrian school in optics, mechanics and other branches of physics, Vesalius established human anatomy on a firm foundation, and Harvey proved the theory of the circulation of the blood. It is not surprising that under such conditions academies of literature and science should multiply in Europe.

Among the earliest Italian academies were the academy of history, philology and archeology, founded in Rome by Pomponio Leto in 1457; the Accademia di S. Luca, devoted to the fine arts, established in 1577; and the Accademia della Crusca, founded in 1582, which has published several editions of its great Italian dictionary.[13] In addition to these organizations seriously devoted to the encouragement of literature and the arts, a host of imitations sprang up all over Italy during the sixteenth century. Perhaps the gaiety of their proceedings was considered to find sufficient warrant in the splendid suppers offered to the academy of Pomponio by the wealthy German Goritz, regarding which Ginguéné[14] quotes the remarks of an earlier authority:

> Ainsi, dit avec un juste sentiment de regret, le bon Tiraboschi, ainsi parmi les verres et les jeux d'esprit, on cultivait joyeusement les lettres, et les plaisirs mêmes servaient à en encourager et à en ranimer l'étude.

According to Libri,[15] Leonardo da Vinci founded and directed the first scientific and experimental academy established in Italy.

[12] See the works of Matter, Montucla, Bossut, Whewell, Draper and Weber.

[13] Carutti, "Breve storia dell'Accademia dei Lincei," p. 157.

[14] Ginguéné, "Histoire literaire d'Italie," Vol. 7, p. 353.

[15] "Histoire des sciences mathématiques en Italie," Vol. 3, p. 30.

Another early academy devoted to the pursuit of science was the Academia Secretorum Naturæ of Naples, which dates from 1560.

Of special interest to the modern investigator is the Accademia del Cimento, which possessed a large collection of physical instruments, many of which are now preserved in the Galileo Museum at Florence. The "Saggi di Naturali Esperienze" made in the laboratories of this institution is an admirably illustrated account of early academic activities. The experiments, which are described in great detail, with the aid of excellent woodcuts of instruments, are in some cases attributed to Galileo, Torricelli and other investigators, and in other cases are said to have been first performed in France. They include a wide variety of subjects, such as the effects of artificial freezing on various waters, wines, acids and oils, the compression of liquids, various phenomena in a vacuum, the electrical properties of amber, and the motion of projectiles.

This important volume was published in 1666, ten years after the establishment of the Academy, which lasted only during this period. The one great Italian academy of science which still survives is the Accademia dei Lincei, founded by Federico Cesi in 1603. His vast plans of organization for the Academy, resembling those of the religious and military orders of the day, are described in an unpublished work entitled the "Linceografo." The Academy was to comprise establishments in the four quarters of the world, where the members would lead a common life in the midst of libraries, museums, observatories, laboratories and botanic gardens, provided with every requisite means of research, and in constant communication with the other constituent bodies of the organization. The name *Lincei*, or Lynx-eyed, was taken in recognition of the reputation of the lynx for extreme penetration of vision, *"vedendo non solo quello che è di fuori, ma anche ciò che dentro si asconde."*[16]

After a stormy period of youth, during which Cesi and his three fellow organizers underwent many vicissitudes, the Academy was vigorously revived in 1609. Two years later, to its lasting renown, it was joined by Galileo, whose earliest telescopic discoveries had just been made. Under this stimulus, and aided by the widespread interest in Galileo's work, the Academy now advanced rapidly. While devoting special attention to the mathematical and physical sciences, it did not neglect the cultivation of literature, counting among its members historians, poets, antiquarians and philologists. Its cosmopolitan character is indicated by the diverse nationality of its membership, which was drawn from many of the nations of Europe. An English member of this period was Francis Bacon.[17]

In November, 1612, Galileo communicated his discovery and observations of sunspots, which were published by the Academy under the title "Istoria e Dimostrazioni intorno alle Macchie Solari." The manuscript of this epoch-making discovery is still preserved by the Academy. This was followed in 1622 by his "Saggiatore," published in great haste, to avoid interference from the Church. Two years later he demonstrated at Rome the use of the microscope, so named by Fabri, a member of the Lincei. In 1629 Galileo completed his dialogue on "Due massimi sistemi del Mondo," and proposed to go to Rome to see it through the press.

Limitations of space forbid mention of

[16] Carutti, "Breve storia dell'Accademia dei Lincei," p. 8.

[17] Carutti, *op. cit.*, p. 26.

[18] *Ibid.*, p. 28.

the memorable events of this period, in which the Academy supported Galileo in his difficulties with the Inquisition, and accepted the resignation of Valerio, who had attacked his doctrines. It was a stirring period, full of new and vigorous thought, which sharply conflicted with the traditions of a vanishing age. Led by such men as Cesi, Porta, Galileo and Colonna, the Lincei played a prominent part in the development of the scientific advance of Italy and in the cultivation of the growing love of truth which spread throughout the civilized world. But in 1830 the Academy came to a sudden end, attributed by Carutti to the withdrawal of the patronage of Cardinal Barberini.[19]

Since that date it has seen several revivals, which are described in the history from which the present notice is derived. Reconstituted under Victor Emmanuel II. in 1875 as the Reale Accademia dei Lincei, it now flourishes as the national academy of Italy. The class of physical, mathematical and natural sciences has 55 members, 55 national correspondents, and 110 foreign members. The class of moral, historical and philological sciences has 45 members, 45 national correspondents and 45 foreign members. The president belongs to one class, the vice-president to the other, and each has a secretary and an assistant secretary.[20]

The home of the Lincei in the Palazzo Corsini is admirably adapted for the purposes of an academy. The collections include an extensive library, rich in rare books and manuscripts, and a large gallery of paintings, most of which is open to the public. The annual meeting, held in the great hall of the palace, is a very impressive function, attended by the King and Queen and other members of the royal family, whose keen and intelligent interest in the work of the Academy is a powerful incentive to increased effort and broader usefulness.

A brilliant and inspiring picture of the Paris Academy of Sciences at the zenith of its development and fame may be found in the opening chapter of Merz's "History of European Thought." This Academy organized through the efforts of the far-seeing statesman Colbert, at the period when Newton was engaged in the composition of his "Principia," has probably exerted a more favorable influence on the progress of science than any other similar institution in Europe. Enjoying both the moral and financial support of the French government, and permeated by an enthusiasm for scientific research which led its members to develop the most extensive cooperative projects, it offers a pattern which other academies may well seek to imitate. Great as it remains to-day, the period in its history which deserves our most careful consideration is that brilliant epoch, at the end of the eighteenth century, when France was everywhere recognized as the leader of the scientific world.

The academicians named by Colbert held their first informal meeting in the library of the Hotel Colbert in June, 1666. In the words of Fontenelle, heaven seemed to favor the rising company, which was fortunately able to observe two eclipses within the short interval of fifteen days. The second of these was observed with the aid of an instrument devised by Huygens (who was one of the members), and perfected later by Auzout and Picart—the well-known micrometer of the astronomer.

The original group, composed wholly of mathematicians and astronomers, was soon enlarged to sixteen, through the addition of Claude Perrault, Mariotte and other well-known chemists, physicians and anatomists. Laboratories and collections were

19 *Op. cit.*, p. 97.

20 See revised statutes, Carutti, *op. cit.*, p. 245.

established in the Bibliothèque du Roi, and the astronomical instruments were mounted in the garden, awaiting the completion of the great observatory designed by Perrault, where some of the meetings were subsequently held. Picart undertook the measurement of an arc of the meridian which, when completed by Cassini, removed the last doubt of Newton as to the theory of gravitation. He was also sent to Denmark to determine the position of the ancient observatory of Tycho Brahe. Geographical maps were corrected and the latitudes and longitudes of a great number of points were measured. Richer went to Cayenne to determine the length of the pendulum and to make other observations. In short, the greatest activity reigned under the personal stimulus of Colbert, whose correspondence shows how large an amount of time he devoted to the interests of the Academy. Well-known names were added to the list of members, including those of Roemer, who determined the velocity of light from the eclipses of Jupiter's satellites; Cassini, the first of a remarkable lineage of astronomers; the anatomist du Verney; and the great Leibnitz.

Under Louvois, the successor of Colbert, the Academy languished, but Bignon's plan of reorganization, adopted in 1699, inaugurated a new period of progress. The Academy was provided with quarters in the Louvre, where it remained until Napoleon assigned to the Institute the former College Mazarin which it still occupies. Its unpublished memoirs were promptly printed, and were so favorably received by the public that as many as three editions were sometimes demanded. At this period a class of "associés libres" was established, to which such men as Turgot, the engineers Perronet and Belidor and Bougainville the explorer have since belonged.

During the eighteenth century the Academy attained a height only surpassed during the brilliant epoch following the Revolution. Among the important events of this century were the mathematical researches of Clairaut and d'Alembert; the expeditions of Clairaut and Maupertuis to Lapland and of Godin, Bouguer and La Condamine to Peru, for the measurement of arcs of the meridian; the similar undertaking of La Caille at the Cape, where he also determined the lunar parallax in cooperation with astronomers in the northern hemisphere; and the observations of the transits of Venus in 1761 and 1769 by Pingré at Rodrigues' Island, LeGentil in India, and Chappe in Siberia and California. The Cassinis continued their extensive astronomical and geodetic investigations in France, where the activity of astronomical research is illustrated by the fact that when Bernouilli came to Paris in 1760 he found, in addition to the original observatory, eight or ten other observatories engaged in investigation under the direction of academicians. Lalande, known as a severe critic, wrote in 1766:

> The collection of Memoirs of the Academy of Sciences is the richest storehouse of astronomical knowledge which we possess.

But the work of the Academy was by no means confined to astronomy and its sister sciences. Through the investigations of its chemists, the way was prepared for the creation of modern chemistry by Lavoisier. Réaumur, Buffon and their contemporaries were making extensive contributions to natural history, while Haüy was laying the foundations of mineralogy. At the same time Geoffroy and the three Jussieus shared with Linnæus the honor of creating the science of botany.

Under such conditions it is not surprising that the nation should turn to the Academy for assistance and guidance in many of its enterprises. Ministers, parliaments,

administrators and state assemblies often sought its aid and accepted its decisions. So commanding was its position that when all the academies were suppressed under the Revolution, it was stipulated that the Academy of Sciences should provisionally continue its functions and receive its annual revenues from the state.

As there are still those who see in a national academy a menace to true democracy, and who criticize our own National Academy on this score, the attitude of the revolutionists toward the Paris Academy is not without interest. In the report on public instruction made by Talleyrand to the National Assembly in 1791, on behalf of the committee, it was proposed to establish a national institute, to continue and extend the functions of the various existing academies.[21] In a later report on behalf of the Committee on Public Instruction, Condorcet showed that the only satisfactory method of determining the membership of such an academy is to leave the elections to the members themselves.[22] Article 298 of the Constitution, adopted August 22, 1795, declares:

> Il y a pour toute la République un Institut national chargé de recueillir les découvertes, de perfectionner les arts et les sciences.[23]

This differed from the former group of academies mainly in the unity of the academic body, which covered the whole range of knowledge (though the Académie Française was not represented), and the equality in number and privilege of the members resident in Paris and the non-resident members of the provinces.[24] Far from losing its prestige through the effects of the Revolution, the Academy of Sciences rose to its greatest success in the years following the Terror, and formed, with its sister academies, the chief connecting link between the modern democracy and the old régime.[25]

The National Institute, as thus constituted, lasted until 1803, when Napoleon Bonaparte again reorganized it. The members of the first class (Academy of Sciences) were grouped in two divisions, containing eleven sections in all. The two secretaries, no longer connected with any section, were made permanent. This organization, with no essential change, still remains in force. The law of 1803 suppressed the national associates, replacing them in the case of the Academy of Sciences by 100 correspondents (national and foreign), increased to 116 in 1899.

It is interesting to remember that Napoleon took an active part in the Academy of Sciences, of which he was elected a member in 1797. During the expedition to Egypt he invariably signed himself "Le membre de l'Institut, général en chef."[26] His appreciation of the importance of scientific research is amply illustrated by the distinguished company of investigators which he took with him on this expedition, where he organized the Institute of Egypt in Cairo, and proposed to establish an astronomical observatory.[27] The extensive and superbly illustrated report of his investigators on the antiquities of Egypt was the first great step in Egyptian archeology, leading to the brilliant labors of Champollion, Mariette and Maspero, and the dominance of the French school in Egypt even under British control.

In the great days of the First Empire began the brilliant period in the history of

21 Hippeau, "L'instruction publique en France pendant la révolution," Vol. I., p. 102.

22 *Ibid.*, p. 327.

23 Simon, "Une Académie sous le Directoire," p. 39.

24 Simon, *op. cit.*, pp. 44, 46, 50.

25 Maury, "L'ancienne Académie des Sciences," p. 1.

26 Simon, *op. cit.*, p. 40.

27 "Mémoires sur l'Egypte," Paris, An. VIII.

the Academy which Merz so justly emphasizes. With such members as Lagrange, Laplace, Legendre and Cauchy in mathematics; Messier, Arago, Lalande and Delambre in astronomy; Biot, Ampère, Fourier, Fresnel, Becquerel and Regnault in physics; Berthollet, Gay-Lussac, Dulong, Dumas and Chevreul in chemistry; Cuvier, de Jussieu, Lamarck and Geoffroy Saint-Hilaire in biology, and with others equally celebrated in other fields, it is not surprising that the Academy commanded the respect and the admiration of the civilized world.

Some of the elements which have entered into the success of the Paris Academy are not difficult to recognize: The sympathy and support of such statesmen as Colbert and Napoleon, who appreciated the fundamental importance of science to the nation, as Alexander the Great and the Ptolemies had done before them; the cooperative spirit which led the members to work together for a common cause; the perfection in the hands of the academicians of the powerful mathematical methods which contributed so largely to the application and widespread usefulness of Newton's discoveries; and the popularization of science and the diffusion of the scientific spirit through the brilliant writings of Cuvier, Laplace, Buffon, Fontenelle and many others. Far from disdaining the translation of technical papers into attractive literature, these great leaders set an example which was followed hardly less effectively, though in a different manner, by Davy and Faraday at the Royal Institution. Cuvier, above all others, represented the academic system at its best. In his eloquent Éloges on the most eminent scientific men of the day, he paints a picture of scientific investigation and progress with the hand of a practised artist. The wide field of science, and the rich results flowing from the labors of investigators skilled in many departments of knowledge, has never been more admirably depicted than in the discourses of this distinguished perpetual secretary.[28]

In Germany, the division of the empire into many kingdoms, preventing the centralization which has been so important a factor in France and England, and the prevailing influence of the universities as research laboratories, where every teacher is not only a scholar but a productive investigator, have stood in the way of the development of any such national institution as the Paris Academy of Sciences.

During the eighteenth century the great men of science, including Leibnitz, Euler, Haller, Tobias Mayer, Lambert, Olbers and Alexander von Humboldt, were widely scattered, and in most cases had little to do with the universities, although these were already distinguished for classical scholarship. But by the publication of his "Disquisitiones Arithmeticæ," and the invention of his improved method of calculating planetary orbits, Gauss, of the University of Göttingen, placed himself on a level with the great French mathematicians and inaugurated a new era in German science. By the use of this method, von Zach and Olbers were enabled to recover the first of the minor planets, Ceres, which had been lost on its approach to the sun. Gauss also introduced exact science into the university curriculum, but it was through the work of Jacobi that the great school of German mathematicians was set on foot a quarter of a century later. The contemporary

[28] For the data used in this account of the Paris Academy I am largely indebted to the work of Maury, Simon, Merz and Hippeau, already cited, and especially to the article by Darboux in "L'Institut de France," Vol. 2 (Paris, 1907). See also the useful series of articles by Dr. E. F. Williams on the Paris, Berlin and Vienna Academies in the *Popular Science Monthly*.

establishment of chemical laboratories by the universities, and the widespread influence of Liebig, Mitscherlich and Wöhler, in chemistry, and of Schleiden and Schwann in botany and zoology, determined for all time the place of the German university in science. Schleiden's cell theory of plant structure and growth was the source of a long series of discoveries, which established the supremacy of Germany in physiology.[29]

In spite of the unfavorable conditions already mentioned, four great academies have nevertheless arisen in Germany, those of Berlin, Munich, Leipzig and Göttingen. Among these, partly because of the leadership of Prussia in the German empire and partly from other causes, the Berlin Academy stands foremost. Founded in 1700 as the *Societas Regia Scientarium,* through the influence of Leibnitz and in accordance with his plans, it has contributed in the highest degree to the advancement of German scholarship. Its present designation as "Akademie der Wissenschaften" indicates the broad scope of its activities. The fifty regular members are divided into two classes, each of which consists of two sections, presided over by a permanent secretary. The first class comprises the sections of physics and mathematics, the second those of philosophy and history. The secretaries preside in turn at the meetings of the separate classes, and at the general meetings, which are held monthly. Each member receives an annual stipend of 900 marks, while the secretaries are paid larger salaries. There are also two positions carrying salaries of 12,000 marks each, filled by the astronomer and the chemist of the academy, and a dozen similar pensions which may be distributed at discretion.

In the early days of its history, the Berlin Academy devoted most of its resources to the establishment and maintenance of research laboratories and museums. Its headquarters were originally in the Berlin Observatory, which was conducted under the direction of the Academy, and it also brought together an anatomical collection, a mineralogical museum, and a zoological garden. Furthermore, the chemist of the Academy conducted his researches in a chemical laboratory provided for the purpose.[30] In 1809, when the University of Berlin was established to compensate for the loss of Halle by the treaty of Tilsit, these functions of the Academy were transferred to the university and have since remained under its direction. In an interesting and important manuscript by Wilhelm von Humboldt, entitled "Ueber die innere und äussere Organization der wissenschaftlichen höheren Anstalten in Berlin," his ideas on the relationship between the academy and the newly organized university are fully set forth. Schleiermacher had defined the university as a group of students, the academy as a group of investigators: the former concerned with the diffusion of knowledge, and the stimulation of scientific research, the latter with the development of scientific problems themselves. Humboldt believed the main distinction between the two bodies to lie in their form and their relationships rather than in their work. The university always remains in close relationship with practical life and the necessities of the state, since it is engaged in the practical task of educating the youth of the nation, while the academy is concerned solely with knowledge.

> When only the function of teaching and disseminating knowledge is assigned to the university and its promotion to the academy, injustice is manifestly done the former.[31]

[29] See Merz's "History of European Thought," Vol. 1, Chap. 2.

[30] See Harnack's great "Geschichte der Berliner Akademie der Wissenschaften."

[31] Paulsen, "The German Universities," trans. by Thilly and Elwang, p. 53.

Whereas the university teachers are under common bonds only in the matter of discipline, and are quite independent of one another in other respects, the academy is a society each member of which must submit his work to the judgment of all. Hence, he insists, the idea of an academy as the highest and ultimate freehold of knowledge, and as a corporation which is more independent than any other of the state, must be maintained.

In Humboldt's view, a close interchange of activities between academy and university should be provided for. Each academician must have the right to lecture at the university without going through the ordinary preliminaries, and without involving any direct connection with it. Many scholars should be both university professors and academicians, but both institutions should have other members who belong to it alone. The academy must be free to choose its own members, subject only to the approval of the government, while professors in the university should be appointed exclusively by the state.[32]

In spite of the transfer of some of its principal departments to the University of Berlin, the Berlin Academy has by no means relinquished its important object of carrying on large research projects. As already stated, it still has an endowed professorship of chemistry, recently held by van 't Hoff, and now by Fischer, and a professorship of astronomy, held by Auwers. Both of these investigators pursue their researches under the auspices of the Academy. The great work upon which Professor Auwers is engaged is characteristic of many of the larger undertakings of the German academies, to which they devote nearly half of their available funds. This is the "Geschichte des Fixsternhimmels," an immense catalogue of star positions based upon the observations of many astronomers. Similar undertakings by the Berlin Academy in other fields are the "Corpus inscriptorum græcarum" and the "Corpus inscriptorum latinarum." The preparation of a great edition of Aristotle's works, begun by the Berlin Academy in 1821 and finished in 1909, is cited by Diels as a most striking illustration of the advantage of academic continuity, with which no individual can hope to compete.[33] For such an undertaking, which we have come to regard as characteristically German, an organized body like an academy of sciences possesses, not merely the advantage of continuity, but that which results from the combined experience and the wide range of vision brought to bear through the coöperation of many eminent authorities. An academy may also command far more extensive material than would fall within the reach of the individual worker. This phase of academic activity, practised in different forms in the Museum of Alexandria and, in the preparation of national dictionaries, by the Académie Française and the Accademia della Crusca, is also illustrated in England by the Royal Society's "Catalogue of Scientific Papers." Our own National Academy has yet to take any steps in this direction.

The importance attached to this form of academic work in Berlin is clearly illustrated in the plans of the new academy building, for a set of which I am indebted to the kindness of Professor Diels. This building, which is being constructed in connection with the new Royal Library, is probably more perfectly adapted for academic purposes than any other building now in use, as it was especially designed

32 Lenz, "Geschichte der Universität Berlin," Bd. I., pp. 186–188.

33 Diels, "Die organisation der Wissenschaft," in "Die Allegemeinen Grundlagen der Kultur der Gegenwart," 2d ed., p. 667.

for the work to be carried on in it.[34] The plans show that one room each is to be devoted to the *Corpus medicorum Græcorum,* the *Acta Borussia,* and the Plant Kingdom, three rooms to the *Corpus inscriptorum Latinarum,* four to the Oriental Commission, four to the Egyptian Dictionary, eleven to the *Inscriptiones Græcæ,* eleven to the German Commission, two to the edition of Leibnitz's collected works, seven to the History of the Fixed Stars. In addition to all of these rooms for special research, there are the great "Fest Saal," separate meeting rooms for the two classes of the Academy, a general meeting room for both classes together, a large anteroom, a demonstration room, seven editorial rooms, four secretaries' offices, offices for the registrar, the recorder and the chancellor, a reading-room and large library and stack room, a correspondence room, an instrument room, a photographic laboratory, and various other offices, kitchens, servants' rooms, etc.

It is a significant fact that Merz, after devoting an eloquent chapter to the evolution of science in France under the stimulus of the Paris Academy, barely mentions the German academies when discussing the progress of science in that country. The reason, as we have already seen, lies in the predominating influence of the universities in the development of German scientific life and thought. With every teacher an investigator, every university a laboratory of research, and with the powerful aid of the state encouraging in every possible way the prosecution of investigation no less than the instruction of students, it is easy to see how the universities obtained their ascendancy in the field of science, or rather in the broad field of *Wissenschaft,* for in Germany the same spirit of research has permeated every department of knowledge. The wide distribution of the universities and their considerable number, together with the free interchange of professors and students, have worked against centralization, and have served to create a cosmopolitan spirit in striking contrast with that which obtains in France. One can hardly fail to believe that no single influence could be more effective than the universities for the development of the latent capacity of a nation for scientific research. But while the German academies have doubtless suffered by contrast with the universities, a survey of the intellectual progress of Germany should by no means overlook the invaluable services they have rendered.

It would seem, however, that these services might have been even greater if a larger number of the scientific men of the nation could have taken an active part in the work of the academies. As at present constituted, the membership of these bodies is extremely limited, and the requirement that each member must reside within a very short distance of the seat of the academy, so that he may be able to attend the meetings regularly, is in striking contrast with the wider membership and freer interchange which seem to have been essential elements in the extraordinary development of the university system.

When we pass to England, and examine into the conditions of intellectual progress, we find a fundamentally different condition of affairs. This reflects the natural characteristics of the English people, just as the university system of Germany and the academic activities of France illustrate the essential qualities of these nations. Merz's picture of the growth of scientific research in England is in some respects a somber one. In his view the Royal Society appears to have played no part in advancing the

[34] Most of the European academies are housed in palaces or similar buildings formerly used for other purposes.

intellectual life of the nation and the Royal Institution, as well as Oxford and Cambridge, fare little better at his hands.

Now no one will attempt to deny that the characteristic quality of British science has always rested in the individual, and that organized efforts there have played a less conspicuous part than in France or in Germany. During a large part of their history, Oxford and Cambridge have done little for research, though the past half century has seen an extraordinary change in this respect, particularly in the case of the Cavendish laboratory, whose succession of brilliant leaders can hardly be matched in the history of any other university laboratory. Men whose names are famous in science have sprung up in the most unexpected places, without ancestry, training or encouragement to account for the dominant influence they have exerted on the scientific thought of the world. A notable illustration of this kind is afforded by Faraday, whose obscure origin, extreme poverty, and lack of the assistance of schools, were most fortunately offset by his transcendent genius and by the influence of Davy, whose lectures at the Royal Institution soon transformed the bookbinder's apprentice into Davy's brilliant successor. Darwin, though of distinguished ancestry, was another English "amateur" whose work was done apart from the universities. A host of others might be mentioned, whose extraordinarily original contributions to scientific thought have found few equals in other lands. For the most part, they have worked alone and sometimes unaided, and their great results have been achieved in spite of conditions which may appear unfavorable and discouraging. But in my opinion the Royal Society and the Royal Institution, not to speak of other important agencies, such as the societies devoted to special branches of science, have exercised in England a profoundly favorable influence which can not be ignored.

In failing to take note of this in his classic work, Merz seems to exhibit some traces of that pessimistic quality which is not infrequently encountered in English life. It is to short-sightedness of the government and to individual conservatism, tinctured with pessimism, that I should be inclined to charge that lack of support of scientific men of which Merz so feelingly complains, rather than to the Royal Society and other organized bodies for the promotion of science. As a matter of fact, it is easy to show that these institutions have exerted a powerful stimulus, without which the progress of science in England undoubtedly would have been delayed.

In the first place, the Royal Society has extended the distinction and privileges of its fellowship to a much larger number of investigators than have been similarly honored by the continental academies.[35] Every investigator in science will understand and appreciate the benefit which such recognition entails. Most of all the obscure individual worker, unnoticed and unsupported by the universities, but wholly devoted to the pursuit of science, must benefit by such moral support. On the continent I have known investigators of this type, not connected with a university, and receiving no aid or encouragement from neighboring university men, who could not be recognized by election to the academies because of their limited membership or their fixed traditions. In England such men would have been received into the Royal Society, which would have been glad to publish their papers as Fellows and to aid them in other ways.

A notable illustration is afforded by the case of Newton, elected a fellow of the

[35] Fifteen new members are elected annually, making a total membership of 477 (Jan. 1, 1913).

Royal Society on January 11, 1671, and subsequently its president for the long period of twenty-four years. A month following his election, Newton communicated to the Society his discovery of the composite nature of white light, which, when published in the *Philosophical Transactions*, was the first of his productions to appear in print. In expressing his thanks to the Society, Newton remarked:[36]

> It was an esteem of the Royal Society for most candid and able judges in philosophical matters, that encouraged me to present them with that discourse of light and colors, which since they have so favorably accepted of, I do earnestly desire you to return them my most cordial thanks. I before thought it a great favor to be made a member of that honorable body, but I am now more sensible of the advantage: for believe me, Sir, I not only esteem it a duty to concur with them in the promotion of real knowledge, but a great privilege, that, instead of exposing discourses to a prejudiced and censorious multitude (by which means many truths have been baffled and lost), I may, with freedom, apply myself to so judicious and impartial an assembly.

Leuwenhoeck, "the father of microscopical discoveries," who communicated no less than 375 papers and letters to the Society during a period of fifty years, bequeathed a collection of microscopes "as a mark of my gratitude, and acknowledgment of the great honor which I have received from the Royal Society."[37]

When the Royal Observatory was established at Greenwich, the government failed for a period of nearly fifteen years to furnish it with a single instrument. In this extremity Flamsteed appealed to the Royal Society, with the following result recorded in the minutes:

> It was ordered that the astronomical instruments belonging to the Society be lent to the Observatory at Greenwich, and that Mr. Hooke's new quadrant be forthwith finished at the charges of the Society.[38]

Examples of this nature might be multiplied indefinitely, but a single case will suffice, since no more striking instance of the splendid results directly due to the encouragement and aid of the Royal Society could be asked than that illustrated in the life and work of Sir William Huggins, one of the founders of astrophysics, and a typical example of the English "amateur" investigator.[39] Sir William, to whose addresses as president of the Royal Society we shall have occasion to refer later, was not a university man. With his accomplished wife as his only assistant, he lived and did all his work at Upper Tulse Hill, well removed from the bustle of Piccadilly on the Surrey side of the Thames. It is more than probable that without the stimulus and aid of the Royal Society much of his great work could not have been done. For it was on returning home from a Royal Society meeting in company with his friend Miller that he first conceived the idea of observing the spectra of stars, and it was with telescopes and other instruments loaned to him by the Society that his classic observations were made. In spite of fogs and clouds of London smoke, he continued his work up to the very end of his long life, dividing his allegiance to science only between his astrophysical investigations and the development of the Royal Society, of which he was for forty years a leading Fellow.

Thus, in spite of that early poverty which prevented the Royal Society from publish-

[36] Weld, "History of the Royal Society," Vol. I., p. 237. Brewster's "Life of Newton" gives an interesting account of Newton's relations with the Royal Society and his plan for its improvement (Vol. I., p. 102).

[37] Weld, *ibid.*, p. 245.

[38] Weld, *ibid.*, p. 255.

[39] It is hardly necessary to say that the term "amateur" is used here to denote one who works in science for the pure love of the subject, and not in the sense of dilettante.

ing the "Principia" of Newton, it has lent its powerful aid and support to many a British investigator, who without it would have been absolutely isolated. Its large collection of instruments, the accumulation of more than two centuries, is freely placed at the disposal of those who need them. Its *Philosophical Transactions* and *Proceedings* have furnished the most desirable means of publication for an enormous mass of scientific literature. Its meetings bring together every Thursday at Burlington House the leading scientific men of the kingdom, and furnish an opportunity for stimulating interchanges of view which have played a great part in scientific progress. Its various gold medals, impartially bestowed at home and abroad, in recognition of advances in science, have been powerfully supplemented by financial assistance to investigators from the Government Grant Fund of £4,000 per annum, which is administered by the Society. To its influence is largely due the high standard of efficiency maintained by the government in its appointment of astronomers royal and other directors of the scientific research of the nation. When the government decided to establish a national physical laboratory it turned at once to the Royal Society, to which it delegated the planning and control of this great institution. Its *Catalogue of Scientific Papers*, continued as the *International Catalogue of Scientific Literature*, has contributed in a most important way to the accessibility and usefulness of the literature of science, and is indispensable to every investigator. It has supplied both money and instruments to scientific expeditions sent to all parts of the globe, and provided for the suitable reduction and discussion of the observations obtained. It has aided the government of India in the work of the Indian Meteorological Department and participated with the meteorological office in the direction of the work of the Kew and its sister observatories. The reports of the Sleeping Sickness Commission have advanced in an important degree our knowledge of tropical diseases. In fact, one could point to an almost unlimited number of illustrations of the beneficent activities of the Royal Society as the leading representative of British research, and as one of the most powerful factors in broad projects of cooperation, such as those of the International Association of Academies.

Unlike the academies of St. Petersburg, Berlin, Vienna and Stockholm, which maintain large research laboratories or support research professorships, the Royal Society has no laboratories of its own. Closely allied with it, however, is the Royal Institution, formerly known as "the workshop of the Royal Society." No laboratory in existence can match its extraordinary record, accomplished at an almost incredibly small cost.[40] When one recalls Young's great work in laying the foundation of the wave-theory of light, not to speak of his success in discovering the first clue to the translation of Egyptian hieroglyphics; Davy's long series of discoveries in chemistry, and his brilliant lectures and demonstrations; Faraday's unparalleled achievements in physical and chemical research, and the dignity and luster he imparted to the popular presentation of scientific results to a general audience; Tyndall's success in the same lecture-hall, and his services in popularizing science in the United States; and the long series of important investigations, especially in the fruitful field of low temperature phenomena, which we owe to Dewar, who has now occupied the chair of chemistry even

[40] Dewar, address as president of the British Association, Belfast, 1902, p. 11.

longer than Faraday: these form a record remarkable in the annals of science, with returns so rich as to be worthy of the expenditure of almost any sum. But even this long list does not represent the total product of the laboratory, where such eminent leaders as Lord Rayleigh and Sir Joseph Thomson have also conducted investigations of the first importance. So far as my own observations have gone, no other laboratory holds such an atmosphere of research or stimulates so powerfully the imagination of the investigator. I shall have occasion later to refer to the equally remarkable success of the Royal Institution in diffusing and popularizing knowledge through its course of experimental lectures.

Academies of the first class are so numerous that only a few of the oldest organizations, whose work bears directly upon the problems of our own National Academy, can be mentioned in this paper. I hope to have opportunity at some future time to describe the work of such influential bodies as the Vienna Academy, which has founded a Radium Institute and taken steps which should result in the establishment of a Solar Observatory; the Stockholm Academy, entrusted with the responsibility of awarding the Nobel Prizes in physics and chemistry; the Amsterdam Academy, focus of the great research work of Holland; and many other academies of the highest rank representing the various nations of Europe. For the present I must limit attention to a group of institutions which are sufficient to typify the wide range of academic activities. However, a word must be added regarding the St. Petersburg Academy, established by Catherine I. on the plans of Peter the Great in 1725, because of its special plan of organization. The president, director and fifteen members are paid annual stipends ranging from one thousand to three thousand dollars, and provided with dwelling houses. The great academy building, with its library of over 36,000 books and manuscripts, contains large laboratories in which investigations are constantly in progress. The extensive publications include researches in every field of knowledge and exhaustive memoirs on the topography, geography and history of Russia and the manners, customs and languages of its various peoples.

From this survey of the work of a few of the leading academies and allied institutions, we see that original investigations have played a large part in their activities, from the days of the great museum at Alexandria to the present time. In certain instances, illustrated in the history of the University of Berlin, some of the work of investigation has been transferred from the academies to the universities, but without interrupting the larger activities of the academies in the same field. Again, in cases like that of the Royal Society, the development of a closely allied laboratory of research, such as that of the Royal Institution has partially supplied the place which a laboratory under the exclusive control of the Society might have held. The essential thing to note is the advantage which results from the organic relationship of an academy with a laboratory for the production of new knowledge. An academy will reach its greatest influence, and serve its most useful purpose in stimulating the work of its members, when it is recognized as an institution primarily "for the increase" rather than "for the diffusion of knowledge among men."

In the field of publication, the great academies of former times were predominant factors, so much so that we owe to their printed pages the great volume of the original contributions of the earlier days of science. With the rapid extension of

the facilities for research, and the extensive ramifications of science into special fields, the societies and journals devoted to particular lines of research naturally arose and multiplied. The prestige of such publications as the *Proceedings* and *Transactions* of the Royal Society fortunately enables them to hold their own, in spite of the competition of so many journals devoted to special subjects. And the opportunity afforded by academies for the publication of extended memoirs beyond the range of ordinary periodicals, is universally appreciated. As regards shorter communications, the peculiar claims of the special journals, which have been proved by time to serve the purposes for which they were designed, would naturally receive consideration in elaborating any new plan of academic publication to meet existing needs. This subject will be more fully considered in a later paper.

In the management and distribution of trust funds for research, the loan of instruments, the award of prizes, and especially in the advice of governments and individuals as to the best means of initiating and conducting scientific enterprises, national academies occupy a position which private foundations can hardly hope to rival. The value of advice received from a body of the highest reputation and prestige is greatly enhanced, because of the increased probability that it will be heeded and carried into effect. For a similar reason, recognition of individual achievement through the award of prizes or election to membership acquires its greatest weight when received from such a body.

After reviewing all of the activities which we see so diversely exemplified by the national academies of different countries, the conviction is forced upon one that the first and best object of these bodies must always be to uphold the dignity and importance of scientific research, and to diffuse throughout the nation a true appreciation of the intellectual and practical benefits which will inevitably result from its support and encouragement. But to accomplish great results in this field, an academy must enjoy the active cooperation of the leaders of the state. To appreciate this, we have only to remember the many striking illustrations afforded in the history of civilization. What was done by Alexander the Great and the Ptolemies for Egypt, by the house of Medici for Italy, by Richelieu, Colbert and Napoleon for France, can be done for other nations by living statesmen to-day. In the midst of his campaigns Napoleon never forgot the paramount claims of science and the arts. Writing to the astronomer Oriani from Milan, which he had entered in triumph, Napoleon said:

> The sciences which do honor to the human mind and the arts which embellish life and perpetuate great achievements for posterity, should be especially honored under free governments.
>
> . . . I invite the scholars to meet and to give me their opinions as to the means that should be taken, and the needs to be fulfilled, in order to bring new life and activity into the sciences and the fine arts. Those who wish to go to France will be received with distinction by the government. The French people set a higher value on the acquisition of a skilled mathematician, a celebrated painter or a distinguished man of any profession, than upon the possession of the largest and richest city.[41]

That such views are still shared by modern rulers is illustrated by the recent establishment of a great institution for scientific research by the Emperor of Germany.

This article can not be better closed than by a quotation from Laplace, the most distinguished member of the Paris

[41] Maindron, "L'Académie des Sciences," p. 205.

Academy in its brilliant days under the first empire.

Nature is so varied in her manifestations and phenomena, and the difficulty of elucidating their causes is so great, that many must unite their knowledge and efforts in order to comprehend her and force her to reveal her laws. This union becomes indispensable when the progress of the sciences, multiplying their points of contact, and no longer permitting a single individual to understand them all, throws upon a group of investigators the task of furnishing the mutual aid which they demand. Thus the physicist appeals to the mathematician in his efforts to arrive at the general causes of observed phenomena, and the mathematician in his turn consults the physicist, in order to render his investigations useful by practical applications, and in the hope of opening up new possibilities in mathematics. But the chief advantage of academies is the philosophic spirit which must develop within them, thence diffusing itself throughout the nation and permeating every interest. The isolated scholar may yield with impunity to the tendencies of the systematist, since he hears only from afar the criticism that he arouses. But in an academy the impact of such tendencies ends in their destruction, and the desire for mutual conviction necessarily establishes the rule of admitting only the results of observation and calculation. Furthermore, experience has shown that since the origin of academies the true spirit of philosophy has prevailed. By setting the example of submitting everything to the test of severe logic, they have overthrown the preconceived notions which too long dominated science, and were shared by the ablest minds of previous centuries. Their useful influence on public opinion has dissipated errors greeted in our own time with an enthusiasm which would have perpetuated them in earlier days. Equally removed from the credulity which denies nothing and the conservatism which would reject everything that departs from accepted ideas, they have at all times wisely awaited the result of observation and experiment on difficult questions and unusual phenomena, promoting them by prizes and by their own researches. Measuring their approval no less by the greatness and difficulty of a discovery than by its immediate utility, and convinced, by many examples, that what appears to be least fruitful may ultimately yield important consequences, they have encouraged the pursuit of truth in all fields, excluding only those which the limitations of the human understanding render forever inaccessible. Finally, we owe to them those great theories, elevated by their generality above the comprehension of the layman, which through numerous applications to natural phenomena and the arts, have become inexhaustible sources of happiness and enlightenment. Wise governments, convinced of the usefulness of scientific societies, and regarding them as one of the principal causes of the glory and prosperity of empires, have established such bodies in their very midst, in order to profit by their counsel, which has often brought lasting benefits.[42]

George Ellery Hale

THE BALTIMORE MEETING OF THE NATIONAL ACADEMY OF SCIENCES

The National Academy of Sciences will meet November 18 and 19 at the Johns Hopkins University, Baltimore. The council will meet the evening before; and on these two dates there will be public sessions with papers by members of the academy and others.

A preliminary program of these papers is as follows:

Henry Fairfield Osborn: *Final Results on the Phylogeny or Lines of Descent in the Titanotheres.*

Thomas H. Morgan: *The Constitution of the Chromosomes as Indicated by the Heredity of Linked Characters.*

The paper is a discussion of recent discoveries in sex-linked inheritance and their bearing on the mechanism of heredity and the constitution of the chromosomes. Starting with the assumption that Mendel's law of segregation finds a plausible explanation in the processes known to occur in the ripening of the egg and sperm, an attempt is made to analyze the ratios that appear in sex-linked inheritance—ratios that depart from those that rest on the assumption of independent assortment of pairs of characters. It is shown how these departures find a reasonable explanation on the assumption that interchange takes place between members of the same pair of chromosomes. The Mendelian ratios, on the

[42] "Exposition du Système du Monde," *Oeuvres*, Vol. VI., p. 418.

other hand, occur when the pairs of factors involved lie in different chromosomes. The method by which the location of loci (factors) in the chromosomes is calculated will be explained.

H. McL. EVANS: *The Action of Vital Stains Belonging to the Benzidine Group.*

S. O. MAST: *Changes in Pattern and Color in Fishes, with Special Reference to Flounders.*

The flounders ordinarily lie on the bottom and the skin assumes a color and pattern so nearly like that of their environment that it is frequently difficult to see them. On a black bottom they become black, on a white bottom white, on a yellow bottom yellow, on a blue bottom bluish, on a red bottom reddish, etc. All of these changes in the skin are regulated through the eyes. This indicates color vision. If the bottom is finely mottled the pattern in the skin assumes a fine grain; if coarsely mottled, it assumes a coarse grain. But there is no evidence indicating an actual reproduction of the configuration of the background. If, after the skin has become adapted to a given bottom, the fish are moved to a different bottom they tend to return to the original. That is, they tend to select a bottom which harmonizes with their skin.

D. S. JOHNSON: *The Perennating Fruits of the Prickly Pears.*

The fleshy fruits of certain prickly pears are not shed, as most fruits are, but remain attached for ten years or more. These fruits continue to grow by a cambium and, while they remain attached, their axillary buds give rise to flowers only. If, however, the chains of fruits thus formed are separated from the plant their buds give rise only to roots and vegetative joints. The plants are propagated in this way. Seeds, though sometimes formed, have never been seen to germinate.

B. F. LOVELACE: *A Static Method for the Measurement of Vapor-pressures of Solutions.*

The method is based upon the principle of the Rayleigh manometer. Vapor from solvent, carefully freed from air, is admitted to one limb of the manometer and vapor from solution to the other limb. The manometer is constructed to give a sensibility of 0.0005 millimeter and readings are made in the usual way by means of a telescope and scale. Provision is made for stirring the solution, also for removing air to less than 0.0004 millimeter pressure, the pressure in system due to air being measurable at any time during the progress of an experiment.

H. C. JONES: *The Absorption of Light by Water Containing Strongly Hydrated Salts.*

Salts, such as magnesium and calcium chlorides, which, in aqueous solution combine with a large amount of the solvent, diminish the power of water to absorb light. Unhydrated salts, such as potassium and ammonium chlorides, produce no such effect. This would indicate that water combined with a dissolved substance has less power to absorb light than free water. This fact is in keeping with a number of others which have recently been brought to light; and they all seem to point to the general correctness of the solvate theory of solution.

SIMON FLEXNER: *Some Factors in the Epidemiology of Infection.*

KNIGHT DUNLAP: *The Fusion of Successive Flashes of Light.*

The least perceptible interval between two light stimuli is dependent on several factors, among which is the relative duration of the stimuli and the dark interval. As determined in extensive preliminary experiments with a beam of light interrupted at its focus by a properly sectored rotating disc, the least perceptible interval ranges from approximately 20 σ when the two stimuli are equal in length to the dark interval, down to 4 σ when the stimuli are 18 times the length of the intervening interval. This variation is principally a function of the length of the first stimulus, the length of the second stimulus having a slight effect of different character. Corresponding measurements for flicker give somewhat lower results, namely, from approximately 11 σ to 2 σ. The difference in these measurements is readily explained.

J. J. ABEL: *Demonstration of an Artificial Kidney.*

HOWARD A. KELLY: *Radio-therapeutics in Surgical Affections.*

A. H. PFUND: *Measurement of Stellar Radiation.*

Using a compensating vacuum-thermocouple with evacuator—both of new design—in conjunction with the 30-inch Keeler Memorial Reflector at the Allegheny Observatory, the radiation from Vega, Jupiter and Altair was observed. The sensibility of the apparatus corresponded to a deflection of 2,400 mm. for a meter—Hefner. The results for the evening of September 22, 1913, were:

Source	Deflection, Mm.	Magnitude	Remarks
Vega........	7.5	0.19	Sky clear; no wind
Jupiter.....	3.0	—2.0	Sky clear; no wind
Altair.......	2.0	0.96	Sky hazy; no wind

(The smallness of the deflection occasioned by Jupiter is due to the circumstance that the image had more than seven times the area of the blackened disc of the thermo-junction.)

J. A. ANDERSON: *A Method for Testing Screws.*

The instrument used is the Fabry and Perot interferometer, and the method is applicable to any screw which has been ground. Periodic errors, errors of run, straightness of the axis, and coincidence of the axis of the screw with that of its pivots can all be determined with a high degree of accuracy. The method has been used in testing the screws for Rowland's ruling machines with success.

J. B. WATSON: *An Experimental Study of Homing.*

This report will discuss briefly four of the more important theories of homing, viz., the "law of counter return"; the theory of return by the aid of "visual land-marks"; the theory of "direct perception of goal" (by the aid of infra-red rays); and the "Spürsinn" of Cyon. The result of three years of experimental work in the Dry Tortugas on homing in the noddy and sooty terns will be given; special emphasis was placed upon the results obtained during the past spring. In brief, the experimenters were able to obtain thirteen returns over open water from distances ranging from five hundred to approximately one thousand miles.

On the afternoons of both the days of the meeting opportunity will be given for visits to several of the laboratories of the Johns Hopkins University, besides the Physical Laboratory in which the meetings will be held.

In the laboratories of anatomy, plant physiology, zoology and chemistry special demonstrations will be given of the researches in progress.

There will be the usual social functions, including a reception by Dr. and Mrs. Remsen and a dinner at the Maryland Club to which the Academy is invited by the members resident in Baltimore.

SCIENTIFIC NOTES AND NEWS

ALFRED RUSSEL WALLACE, the great English man of science, author of works on natural selection, geographical distribution and a wide range of biological and social subjects, died on November 7, in his ninety-first year.

SIR WILLIAM PREECE, the distinguished British electrical engineer, died on November 6, at the age of seventy-nine years.

DR. CHARLES MCBURNEY, formerly demonstrator of anatomy and professor of surgery in the College of Physicians of Columbia University, died on November 6, aged sixty-eight years.

A MARBLE bust of Lord Kelvin by Mr. Shannon, A.R.S.A., the gift of Lady Kelvin, was presented to the Royal Society of Edinburgh on October 28, by Professor Crum Brown, on her behalf. Principal Sir William Turner, who presided over a large gathering, said Lord Kelvin had been sixty years a fellow of the society, and was occupying the post of president for a third term of five years when he died in 1907.

AT the annual meeting of the American Mathematical Society, to be held at Columbia University on December 30–31, Dean H. B. Fine, of Princeton University, will deliver his presidential address on "An Unpublished Theorem of Kronecker Respecting Numerical Equations."

AT the dedicatory exercises of the new $100,000 laboratory building of the college of medicine of the University of Nebraska, held in

Omaha on October 16, the two principal speakers were Dr. Howard A. Kelly, of the Johns Hopkins University, and Dr. Henry B. Ward, of the University of Illinois.

Sir Rickman John Godlee, president of the Royal College of Surgeons, England, had the honorary degree of doctor of laws conferred on him at a special convocation of the University of Toronto, November 5. At the Academy of Medicine on the evening of the 4th, Sir Rickman delivered an address on foreign bodies in the air passages.

Dr. Ludwig Radlkofer, professor of botany at Munich, has been permitted to retire from the active duties of his chair.

The special board for biology and geology of Cambridge University has approved a grant of £30 from the Balfour Fund to Mr. George Matthai, B.A., research student of Emmanuel College, in aid of his research on the comparative morphology of the madreporaria.

The address by Professor G. A. Miller entitled "Some Thoughts on Modern Mathematical Research," which appeared in Science, June 7, 1912, has been reprinted in the October, 1913, number of *The Journal of the Indian Mathematical Society*, Madras, India. It has also been reprinted in the "Annual Report of the Smithsonian Institution of Washington" for 1912.

UNIVERSITY AND EDUCATIONAL NEWS

Complete plans for the new home of the Massachusetts Institute of Technology have been made public. There are to be nine contiguous buildings, each devoted to a separate department. Construction has already been started on the Cambridge side of the Charles River, east of Harvard Bridge. The principal buildings are expected to be ready for occupancy in two years. Of the $10,000,000 necessary, $7,300,000 has already been pledged.

The Chamber of Commerce of New York City announces a gift from a donor whose name is withheld of $500,000 for a building for a college of commerce. Gifts have also been received of $50,000 from four other subscribers. The Chamber of Commerce proposes to provide a building and to install a commercial and civic museum on condition that the City of New York provides the running expenses.

The University of California announces that the income of the $120,000 given by Mrs. Jane K. Sather to endow the Sather professorship in classical literature is to be used for a visiting Sather professor. Annually some distinguished scholar, from Europe or from America, will be called to Berkeley to spend a half year or a year teaching in the University of California. The first incumbent is to be Professor John L. Myres, of Oxford University, who will come from his present work of excavation in the island of Cyprus. Besides liberally endowing the Sather professorship in classical literature, Mrs. Jane K. Sather, of Oakland, gave a like amount to endow the Sather professorship of history, now held by Professor H. Morse Stephens; endowed the three Sather book funds, to purchase works in classics, history and law; built the Sather Gate, in memory of her husband, at a cost of $37,000, and gave $200,000 for the three-hundred-foot white granite Sather campanile, now being built on the campus, and $25,000 for the Sather bells, a set of chimes which are to be placed in the open belvedere of the campanile, 250 feet above the level of the campus.

The University of Florida will use two new buildings for the first time at the coming session: the Language Hall, costing $45,000, will house departments of law, languages, English history, mathematics and administrative offices; the George Peabody Hall, for the teachers college and normal school, costing $40,000, the gift of the General Education Board, will house the general library, departments of education and philosophy, normal school and practise high schools.

The president of the Ohio State University and a group of members of the legislature have visited the universities of Wisconsin, Michigan and Illinois to obtain information for the development of the Ohio State University.

Dr. Hollis Godfrey, an engineer of Philadelphia, the author of contributions to chem-

istry and sanitary engineering, has been elected president of the Drexel Institute of Art, Science and Industry.

John Ellsworth Hartzler, the newly elected president of Goshen College, was inaugurated on November 7. President Winthrop E. Stone, of Purdue University, and President Robert L. Kelly, of Earlham College, represented the universities and colleges on the program on this occasion.

The following appointments have been made in the school of civil engineering, Purdue University: H. B. Smith, instructor in railway engineering; A. L. Dierstein, instructor in structural engineering; W. E. Stanley, assistant in surveying.

Recent appointments in science in West Virginia University are as follows: Wm. Henry Schultz, Ph.D., professor of pharmacology and materia medica; Aaron Arkin, M.D., Ph.D., professor of bacteriology and pathology; A. H. Foreman, E.E., M.E., Ph.D., assistant professor of electrical and experimental engineering; L. I. Knight, Ph.D., plant physiologist in the experiment station, in cooperation with the University of Chicago; E. L. Andrews, assistant professor of poultry husbandry; Isaac B. Johnson, B.S.Agr., instructor in animal husbandry; Oliver Smith, B.S.-Agr., instructor in agronomy; W. B. Kemp, B.S.Agr., instructor in agronomy; O. M. Kile, B.S.Agr., agricultural editor; John Heron Illick, M.S., instructor in zoology; Joseph W. Hake, M.S., instructor in physics; Hubert Hill, B.S., instructor in chemistry; W. A. Price, Ph.D., instructor in geology; Edward F. Woodcock, M.A., instructor in botany.

Recent appointments at the University of Florida include: L. W. Buchholz, A.M., and W. S. Cawthon, A.M., as professors of education in the newly organized teacher's college; R. R. Sellars, B.S. (Bucknell), instructor in civil engineering; A. J. Strong, B.S. (Mich. Agr.), instructor in mechanic arts, both in college of engineering; Ira D. Odle, B.S. (Purdue), instructor in botany and bacteriology; J. F. Duggar, Jr., M.S. (Ala. Poly.), instructor in agronomy, in the College of Agriculture. In the Agricultural Experiment Station, laboratory assistants have been appointed as follows: A. C. Mason, B.S. (Mich. Agr.), in entomology, J. Matz, B.S. (Amherst), in plant pathology. O. F. Burger, assistant plant pathologist, has been granted leave of absence for study at Harvard University.

The extension division of the University of Florida was made a separate and independent portion of the university organization, with P. H. Rolfs, as director, and A. P. Spencer, as vice-director. All extension service will be concentrated in this division, including farmers' institutes; farmers' demonstration and boys' and girls' club work, in cooperation with the Bureau of Plant Industry of the United States Department of Agriculture; literary and scientific lecture bureau; instruction for teachers and county institutes; correspondence courses, etc.

Mr. A. G. Steele has been appointed head of the department of psychology in Temple University, Philadelphia, Pa.

Professor Franz Cosmat, of Gratz, has been called to the chair of geology at Leipzig.

Dr. Adolf Windaus, of Freibourg, has accepted the chair of chemistry at Innsbruck.

DISCUSSION AND CORRESPONDENCE

ABSORPTION OF THE SUN'S ENERGY BY LAKES

To the Editor of Science: The Wisconsin Geological and Natural History Survey has been making a study of the rate at which the energy of the sun's rays is absorbed as they penetrate the water of lakes. Two instruments have been used for this purpose. The first is a black-bulb thermometer *in vacuo;* a so-called solar thermometer. The instrument is exposed to the action of the sun at different depths, say 1 m. and 2 m. from the surface. The rate of rise of the mercury is noted and from the relation of the rates at the two depths can be computed the amount of absorption of heat in the stratum between them. The second instrument is a thermopile and galvanometer, designed for the purpose by Professor C. E. Mendenhall, of the department of physics, University of Wisconsin, and constructed in

the university shops. The method of observation is much the same as with the solar thermometer, but the instrument is much more sensitive and rapid in its action. Readings are made in a few seconds and the instrument will easily record an amount of heat as small as 1 per cent. of that present at the surface. The results obtained by the two instruments are in substantial agreement. Observations have been made on a stratum of water of considerable thickness (1 m. or 0.5 m.) and have usually dealt with strata beginning at 0.5 m. or 1 m. below the surface—a depth at which all, or nearly all, of the invisible part of the spectrum has been absorbed.

It has long been known that a stratum of optically pure water 1 m. thick absorbs about 60 per cent. of the sun's energy, including nearly all of that below the *A* line. In pure water the absorption below one meter would amount to less than 12 per cent. of the energy present at a given depth in the 1 m. stratum immediately subjacent. These figures are subject to variation, depending on the altitude of the sun and the form of the energy spectrum.

Lake water is optically very different from pure water. The inland lakes of Wisconsin are not very transparent; the transparency, as shown by Secchi's disk, varying from less than 1 m. to about 7 m. The transparency is affected both by turbidity, due to suspended matter, and to stain, occasioned by matters extracted from peat, etc.

Observations made on more than twenty-five lakes showed that not more than 20 per cent. of the sun's energy present at the surface is found at a depth of 1 m., and the amount is usually much less; sometimes as low as 2 per cent. or 2.5 per cent. Not less than 30 per cent. of the energy present at 1 m. is absorbed by the stratum of water between 1 m. and 2 m.; usually as much as 40 per cent. to 50 per cent. is absorbed; and the amount may be as great as 85 per cent. to 95 per cent. The rate of absorption per meter is substantially the same in subjacent meters as it is between 1 m. and 2 m. No readings have been made at a greater depth than 6 m., since at greater depths the energy was always too small for accurate measurement.

From these observations it follows that the heat of the sun's rays is practically absorbed entirely by the upper meters of the lake. So much as 1 per cent. of the energy present at the surface is rarely found at a depth so great as 5 m., and usually the 1 per cent. point is reached between 3 m. and 4 m., or even higher. It is quite impossible that an appreciable diurnal rise in temperature should be found in these lakes at the depth of 5 m., and practically the entire seasonal rise of temperature at 5 m. and below is due to mechanical agencies—chiefly, if not wholly, wind—rather than to insolation. It follows also that there is in general no relation between the depth to which the heating of the sun's rays penetrates and the thickness of the epilimnion.

An interesting and (to me) unexpected result of these observations is the not uncommon absence of correlation between the transparency of the water, as shown by Secchi's disk, and the rate of absorption of energy. Stained water may be much more transparent, as measured by the disk, than turbid water which is not stained, but in such cases the rate of absorption of energy may be relatively, or absolutely, greater in the stained water. For instance, Marl lake, whose water is clear but turbid with marl, had on August 21, 1912, a transparency of 1.8 m. and a rate of absorption of the sun's energy below 1 m. of about 55 per cent. per m. On August 17, 1912, Otter lake, a near neighbor, whose water is stained but not turbid, had a transparency of 5.2 m. and an absorption of about 54 per cent. Numerous observations have been made, which give similar results. It may be noted also that bottom growing plants were found abundant to substantially the same depth in these two types of lakes.

This work is still in progress and when completed will be incorporated in a general report on the temperatures of Wisconsin lakes.

I may add that for three years past the heat delivered by sun and sky at Madison has been recorded at the United States Weather

Bureau by a Callendar sunshine receiver and recorder. The temperature of Lake Mendota, on whose shore is situated the station of the Weather Bureau, is ascertained by daily series of observations, taken in the deepest part of the lake. In this way are determined not only the amount and rate of the gain and loss of heat by the lake, but also the relation between the heat absorbed by the lake and that furnished to its surface by the sun.

E. A. BIRGE

MADISON, N. J.,
October 3.

QUOTATIONS

SPECIAL TRAINING FOR HEALTH OFFICERS

A LONG step forward in the special training of health officers has just been taken in the organization of the "school for health officers" of Harvard University and the Massachusetts Institute of Technology.

By cooperation, especially arranged between the two institutions, it now becomes possible for properly qualified persons on payment of an annual fee of $250 to obtain access to the remarkable resources of the Harvard Medical School and other departments of our oldest university, as well as to the chemical, biological, sanitary and engineering opportunities offered by a great modern technical school. How remarkable these opportunities offered are can only be appreciated by an examination of the announcement itself, copies of which may be obtained on application to the director, Professor M. J. Rosenau, of the Harvard Medical School.

No single curriculum is laid down which all must follow, but from the many courses offered members of the school will be expected to choose such as their preparation warrants or their needs indicate. No degree of any kind is required for admission, and no degree will be awarded for the completion of the course but, instead, a certificate to be known as the certificate of public health (C.P.H.) will be given to all who complete satisfactory courses and requirements. In order to obtain the certificate in one year it will in general be required that the candidate shall be either a graduate in medicine, or in biology and public health, or be otherwise highly qualified. Failing these special qualifications, two or more years will ordinarily be necessary in order to obtain the certificate.

No one will be admitted to the school who has not completed at least two years of ordinary college work including chemistry, physics, biology and French and German, or who is not otherwise specially qualified.

Persons already engaged in public health work will be admitted under certain conditions to special courses, and every facility will be offered for obtaining equipment in public health administration and other aspects of the health officers' profession.

It is hardly necessary to say that the organization of this high-grade school marks a distinct epoch in the American public health service. It still remains, however, for the public, which is interested in the success of schools of this sort, to make sure that a reasonable tenure of office and proper salaries shall await those who are ready to devote their lives to the new profession, and much popular education along this line needs to be done.

The actual conduct of the affairs of the school has been placed by Harvard University and the Massachusetts Institute of Technology in the hands of an administrative board, composed of Professor W. T. Sedgwick, Sc.D., of the Massachusetts Institute of Technology, chairman; Professor M. J. Rosenau, M.D., of the Harvard Medical School, director, and Professor George C. Whipple, S.B., member of the American Society of Civil Engineers, secretary.—*Journal of the American Public Health Association.*

PENSIONS AT BROWN UNIVERSITY

AN announcement of the new pension rules for members of the faculty of Brown University was made yesterday at the annual meeting of the corporation. That is about the only one of the great institutions in this part of the country that is not eligible to the benefits of the Carnegie Foundation, and while that might seem to place it at a disadvantage in general competition, its alumni and friends

have shown their willingness to overcome the handicap. The spirit of this university is as liberal as in any other, but some ancient special requirements have been interpreted as placing it outside the prescribed list of beneficiaries. An attempt has been made to revise the charter so as to put it into conformity with the conditions of the foundations, and while that might have been a properly expedient step to take, there may be a feeling of larger satisfaction in attaining the same results through its own efforts. After twenty-five years of service in some cases and fifteen in others, any one connected with the active work of the university is entitled, after the age of sixty-five, to a pension of four hundred dollars, plus fifty dollars for each hundred dollars of active pay. Retirement at seventy is mandatory. This overcomes what otherwise might prove a disadvantage and puts the institution on both a strong and an independent basis.—Boston *Evening Transcript.*

SCIENTIFIC BOOKS

Allen's Commercial Organic Analysis. Fourth edition, Volume VII. Philadelphia, P. Blackiston's Son and Co. 1913. $5.00 net.

Volume VII. of this comprehensive and useful work deals with vegetable alkaloids, glucosides and other "bitter" principles, animal bases, putrefaction bases, animal acids, lactic acid and cyanogen and its derivatives. Like nearly all such extensive compilations representing the joint work of many authors there are to be noted considerable variations in the excellence and value of the different chapters. Hundreds of different compounds of animal and vegetable origin are described. Their formulæ when known are given together with their medicinal value and chemical properties including characteristic tests used for their detection and estimation.

It would be easy to pick flaws in a book of that kind, since much of the material represents compilations of variable value from other books. The individual contributors have evidently been hampered more or less by the decision of the general editors to preserve the classifications of the older editions. Thus the purines are discussed in Taylor's excellent chapter on the animal bases, but uric acid, the most important of the purines, is not included. It is discussed in the chapter on animal acids. Urinary calculi and bile pigments, but not lactic acid, are included in the latter chapter.

To the commercial chemist who has to analyze many different substances and to continually turn from subject to subject, in many instances to subjects with which he has had no experience, this volume of Allen's "Commercial Organic Analysis" will prove a valuable source of information.

Otto Folin

Harvard Medical School

House Sanitation. By Marion Talbot. Boston, Whitcomb & Barrows. 1913.

In view of the rapidly growing conviction that home-making is a science as well as an art, and the increasing purposefulness with which women are preparing themselves for this function, there is no more important need in public health than for authoritative manuals of home sanitation. It was one of the most substantial achievements of the late Mrs. Richards that she saw the need before it was generally recognized and met it by the preparation of a series of books which will always remain as inspiring models for workers in this field. Public health science has developed with such rapidity, however, that every few years makes necessary a revision of the older viewpoints. The reviewer has of late frequently been puzzled when asked to recommend a good book on home sanitation. The Sanitary Science Club of the Association of Collegiate Alumnæ, under the guidance of Mrs. Richards herself, published a book upon this subject twenty-five years ago. It has naturally become in many respects out of date; and the new work just published by one of Mrs. Richards's most distinguished pupils has been so completely rewritten as to constitute an entirely new contribution, and one which shows that the mantle of the pioneer in scientific home-making has fallen on no unworthy shoulders.

It is, indeed, refreshing, to one familiar with

the ordinary type of pseudo-sanitation contained in current literature for the housewife, to find that Dean Talbot in her first chapter quotes as a text Dr. H. W. Hill's statement that "The old sanitation was concerned with the environment, the new is concerned with the individual, and finds the sources of infectious disease in man himself rather than in his surroundings." The following principles of "the new sanitation" immediately follow as illustrations which "show changes in sanitary theory which have been abundantly and conclusively proved."

"Night air is purer than day air, and should be admitted freely to the house.

"Gases from marshes do not cause malaria.

"The quality of the air in the breathing zone is more important than the general air of the room.

"The quantity of carbon dioxide or 'carbonic acid' is not a measure of the unhealthfulness of air.

"Ordinary variations in the normal gaseous constituents of air produce no apparent effects.

"High humidity, combined with high temperature, produces the discomfort ordinarily attributed to 'bad air,' and is unhealthful.

"Ordinary buildings and rooms ventilate themselves to a considerable extent. A small house needs comparatively less provision for change of air than a large building.

"Air from properly constructed sewers is not harmful.

"Sunlight can not be depended on for disinfection or as a substitute for cleanliness. Its value is physiological, psychical, and chiefly moral.

"Actual light rather than window area should be the measure of the efficiency of room-lighting.

"Odors are not harmful physically, but when unpleasant should be eliminated by cleansing methods rather than by ventilation.

"Disinfection as ordinarily practised, especially by amateurs, is practically valueless."

These brief statements, which so well present some of the chief conclusions of recent public health science, almost constitute a syllabus of the book. They are elaborated in eight chapters, dealing with the situation of the House and Care of the Cellar, Plumbing, Air and Ventilation, Heating, Lighting and Light, Furnishing, The Country House and Household Control of Infection, and each chapter is followed by some twenty direct practical questions intended to focus the attention of the housewife on the immediate problems of her own dwelling which fall under the general subject discussed. The viewpoint is throughout thoroughly sound and up-to-date and this little book of 116 pages ought to do notable service in the cause of public health education.

C.-E. A. Winslow

COOPERATIVE INVESTIGATION OF THE MISSISSIPPIAN FORMATIONS

The Mississippian formations of the Mississippi valley states will be studied in cooperation as a result of an important field conference held during October in Missouri. The following states were represented:

Arkansas	Purdue.
Illinois	DeWolf.
Indiana	Barrett, Beede.
Iowa	Kay.
Missouri	Buehler, Hughes.
Ohio	Prosser.
Oklahoma	Ohern, Snider.
Tennessee	Purdue.
U. S. Geological Survey	W. H. Herron.

These formations measure approximately 2,000 feet, and they have been described at various times in the past without much regard for previous usage of stratigraphic units or names. Thus in a single state the same rocks are represented under three distinct names, even in comparatively recent literature.

Since considerable work on the Mississippian formations is now being done, it is important that cooperation be established between the several states concerned, and the U. S. Geological Survey. A permanent committee in charge of this matter on behalf of the states includes H. A. Buehler, of Missouri, G. F. Kay, of Iowa, and A. H. Purdue, of Tennessee. The chief geologist of the U. S. Geological Survey will cooperate with this committee in order to give future work suitable oversight, and in order to prevent friction.

The significance of this cooperative move-

ment will be apparent to all geologists and mining engineers, and it is to be hoped that similar cooperation on work relating to other state problems will be effective in the near future.

F. W. DeWolf,
Secretary

SPECIAL ARTICLES

ON THE ACOUSTIC EFFICIENCY OF A SOUNDING BOARD

The experiments described below appeared to yield such a variety of information, of so definite a character, that it seemed worth while to record them, in spite of their simplicity.

The chapel of Adelbert College, built in 1910, had proved unsatisfactory in its acoustic properties. The architect prescribed a sounding board, as likely to remedy the defect, and sent a sketch embodying his suggestion. It was thought worth while to make a preliminary test before erecting a permanent sounding board, and the writer was asked to take charge of the matter.

The chapel is a building of late English Gothic type. The nave is 104 feet long, with narrow and low side aisles, barely 6 feet wide, including the massive piers. The width of the nave, not including the aisles, is 30 feet. The chancel is 34 feet long and 30 feet wide, without aisles. The chancel floor is raised about 16 inches above that of the nave. Thus the general shape of the building is a long and narrow rectangle, 140 feet by 30, with no important recesses or irregularities. The ceiling is arched, about 48 feet high to the top of the arch. Its curvature is such that any focal line which might be formed by reflection would be not near the floor, but high up in the auditorium.

Experiments gave little evidence of local echo or interference. The acoustic difficulties arise chiefly from general reverberation. The problem was then to determine by direct comparison the value of a sounding board as a corrective of general reverberation.

It is evident that the experiments must be of such a kind as would appeal not merely to a physicist, but to any intelligent person. This means that they must be comparable with the ordinary use of the chapel, and must involve the hearing of ordinary speech. Yet it was of course desirable that they should have some quantitative character, and that the individual and personal characteristics of the hearers should be so far as possible eliminated or averaged.

Several members of the college faculty and two or three advanced students gave their cordial assistance. To their patience and carefulness is due whatever of value these experiments may have.

Three speakers took part, differing greatly in characteristics and in quality of voice, but all accustomed to public speaking.

It is a commonplace that ordinary speech is understood largely by context and association throughout a whole sentence rather than by actual hearing of the individual words. To eliminate this factor, lists of unconnected words were read from a spelling book, at a rate and with intonation similar to that used in a connected passage. One who has not tried this can hardly realize how much we rely on association in listening to an address. In order that this association-factor might not be left entirely out of account, a passage from some oration (always the same oration in any one set of experiments) was read in addition to the spelling-book list.

Three rows of seats on the floor, and the front row of the gallery at the back of the house, were selected as representative of the whole auditorium. The seats on the floor were the seventh, fourteenth and twenty-first from the front, and were called in the tests *G*, *N* and *U*, respectively. The position of the listener in any one row of seats, whether in the middle or on either side of the chapel made no apparent difference in the ease of hearing. The speaker was equally well heard from any part of the row, whether he stood in the pulpit, or in the middle of the front edge of the chancel floor. These facts were established by experiment before the sounding board was put in place.

The sounding board, made after the design of the architect, was of the horizontal type

now generally considered most effective. The horizontal board was hexagonal, six feet in diameter (radius of the inscribed circle), surrounded by a vertical rim which extended six inches below the plane of the board. It was supported at a height of a little more than two feet above the head of the speaker.

After a considerable number of preliminary trials, all of the same general character, a final comparative test was conducted as follows:

Eight hearers assisted, distributed through seats *G*, *N*, *U*, and the gallery. The speaker stood in his appointed place, and read a list of disconnected words from a spelling book, while each hearer noted down the number of words not understood. The speaker then read a short passage, of a known number of words, from the chosen oration, the hearers noting, as before, the words missed. The hearers then changed places, those in *G* going to *N*, those in *N* to *U*, etc., and again a list of words was read from the spelling book, and a passage from the oration. This was continued until each of the eight hearers had sat in each of the assigned seats. The number of words understood by a hearer in a given seat in any one trial was expressed as a percentage of the whole number read during that trial. The average of the percentage numbers for all the eight hearers was taken as the acoustic efficiency of the seat.

Two such sets of experiments were made, the speaker standing, in experiment I., at the front edge of the chancel floor, in the middle; in experiment II., in the pulpit, under the sounding board.

	G	*N*	*U*	Gallery
Unconnected words:				
I. On chancel floor..	96	89	80	66
II. In pulpit...........	98	91	82	62
Connected discourse:				
I. On chancel floor..	99+	98+	95	80
II. In pulpit...........	100	99	96	80

The two sets of experiments should be strictly comparable, as they were made in the same afternoon, and involved the same speakers and the same hearers in the same places. The results follow. The figures represent in each case the average percentage of words understood by the eight hearers.

These results seem to show that the beneficial effect of a sounding board in this place is very small or inappreciable. This is perhaps no more than was to be expected, for it is difficult to give any reason why a sounding board should greatly diminish the reverberation in an auditorium.

The experiments described afforded a considerable amount of other information, with regard to the most advantageous pitch of the speaker's voice, the rate of speaking, and other phases of the subject, but as such results would apply only to the auditorium studied and would have no general value, they have not been discussed.

Frank P. Whitman

Western Reserve University,
October 25, 1913

THE AMERICAN CHEMICAL SOCIETY

ROCHESTER MEETING

III

DIVISION OF PHARMACEUTICAL CHEMISTRY

B. L. Murray, *Chairman*

F. R. Elred, *Secretary*

B. L. Murray: *Chairman's Address. Legislation Affecting Pharmaceutical Chemistry.*

A. W. Bender: *The Determination of Mercuric Iodide in Tablets.*

Several methods and modifications of methods were tried on the tablets with very unsatisfactory results. The difficulty experienced was due in a large measure to the other ingredients in the tablets, namely, terra alba, potato starch, talc and gelatine. The method which was finally found to give satisfactory results is a modification of the sulphide method.

The method consists in dissolving the mercuric iodide by the use of HCl and $KClO_3$, filtering, making the filtrate alkaline with ammonia, and precipitating with H_2S.

The method was also found to be useful for the assay of mercuric iodide and oleate of mercury.

J. B. Williams: *The Insecticidal Value of Fluid Extract of Larkspur Seed.*

Fluid extracts of larkspur seed on the market at the present time show great variation in physical, chemical and insecticidal properties.

Fluid extracts obtained by extracting the seed

with various menstrua, assaying for fixed content and alkaloidal strength and testing insecticidal value on bed-bugs indicate that this preparation owes its insecticidal value more to the fixed oil content than to its alkaloidal strength.

H. V. ARNY and H. H. SCHAEFER: *The Ferric Alum Estimation of Casein.*

CHARLES BASKERVILLE: *Some Physico-chemical Considerations in Reference to Inhalation Anesthetics.*

F. O. TAYLOR: *Amyl Nitrite, Its Preparation, Purity and Tests.*

LOUIS HOGREFE: *The Chemico-legal Interpretation of United States Pharmacopœia.*

Deals with the interpretation of the National Pure-food Law, wherever it is based on the United States Pharmacopœia, especially with the interpretation of the term "drug" as defined by the law, and as understood by the U. S. P. Also the interpretation of "adulteration" as defined by the law. The paper also considers the tests laid down by U. S. P., and their interpretation according to law. Taken as a whole the paper is a brief of sec. 6 and sec. 7 of the pure-food law, as construed by the writer, alike a member of the legal profession and the profession of chemistry.

GASTON DUBOIS: *The Chemistry and Properties of Glycerophosphates.*

A. R. L. DOHME and H. ENGELHARDT: *Purity of Chemicals and Quality of Vegetable Drugs during 1912.*

H. ENGELHARDT and O. E. WINTERS: *Spirit of Nitrous Ether.*

GEO. O. BEAL and EDW. A. GLENZ: *The Composition of the Fruit of the Virginia Creeper, Ampelopsis quinquifolia.*

DIVISION OF INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS

G. D. Rosengarten, *Chairman*

Geo. P. Adamson, *Vice-chairman Presiding*

S. H. Salisbury, Jr., *Secretary*

NORMAN A. DUBOIS: *The Protection of Iron and Steel by Paint Films.*

The theories of corrosion of iron and steel are noted and briefly considered from the standpoint of the paint technologist.

Experiments are described to illustrate the greater protecting qualities of paint films rendered less permeable to the corrosion accelerating gases of the atmosphere. Photographs are shown of exposure tests illustrating the relative increased protection of films containing diffusion retarders.

PERCY H. WALKER and S. S. VOORHEES: *Some Tests of Paints for Steel Subjected to Alternate Exposure to Air and Fresh Water.*

Fifteen paints were included in this series of tests. The tests being designed to compare pigments, the same oil and drier were used throughout. The paints were made up to a definite viscosity and applied to cleaned steel at definite spreading rates. After thorough drying the plates were placed in tanks which were filled with water each afternoon and emptied each morning. Tests were all in triplicate and all represented one, two and three coat work. Details of method of preparation of paints and plates, of painting, exposing and of inspection are given.

CHARLES H. HERTY and C. W. WILLIARD: *The Effect of Resene on Soap Solutions.*

CHARLES H. HERTY and J. O. GRAHAM: *Isoprene from Commercial Turpentine.*

HARRY MCCORMACK: *The Milling of Wheat and Testing of Flour.*

HARRY MCCORMACK: *A New Design of Coke Oven and a New Method of Coking.*

H. C. ALLEN: *The Electrolytic Reduction of Iron for Permanganate Titration.*

J. C. HOSTETTER: *A Method for the Determination of Magnesium in Calcium Salts.*

The essential part of this method is the concentrating of the Mg into a precipitate which contains but a small amount of Ca; after this, the ordinary methods of separation may be employed. This concentrating is effected by precipitating the Mg as $Mg(OH)_2$ with excess of solid $Ca(OH)_2$. The neutral chloride solution of the Ca salt (10 g. to 100 per cent.) is treated with the CaO made by igniting 0.5 gram $CaCO_3$; the solution is heated to boiling and then filtered. The precipitate is dissolved in HCl; the Ca, etc., removed by a double precipitation with NH_4OH and $(NH_4)_2C_2O_4$; and the Mg determined in the filtrate by precipitating as ammonium magnesium phosphate. Determinations of Mg in some 30 highest grade Ca salts are given.

E. S. MERRIAM: *Methods for the Examination of Natural Gas for the Production of Gasoline.*

The natural gas used for the production of gasoline is a mixture of the first 5 or 6 hydrocarbons of the paraffine series. The exact analysis of such a mixture seems possible only by fractional distillation at very low temperatures.

By determining the solubility of the gas in kerosene empirical relations between solubility and actual yield can be established.

By use of a weighed absorption vessel filled with

olive oil, the mean molecular weight of part of the condensible hydrocarbons can be calculated.

Chemical methods are not wholly satisfactory. A small laboratory compressor holding 4 liters of gas and capable of withstanding pressures up to 500 lbs. is described. By its use the yield of liquid gasoline obtainable from any gas under any working conditions of temperature and pressure can be determined quite accurately.

George A. Burrell and Frank M. Seibert: *The Condensation of Gasoline from Natural Gas.*

Sidney D. Wells: *Some Experiments on the Conversion of Long-leaf Pine to Paper Pulp by the Soda and Sulphate Processes.*

One hundred and fifty small autoclave cooks were made to study the influence of various factors in the cooking operation of the sulphate process. It was found that the more caustic soda or sodium sulphide, in use, the greater the concentration, the higher the temperature and the longer the time of cooking, the lower the yields of pulp and the lighter and easier to bleach. Caustic soda had twice the reducing power possessed by sodium sulphid.

Nineteen larger semicommercial cooks were made and with a yield of pulp of 49 per cent. of the dry weight of the wood a kraft paper was made stronger and tougher than the usual imported kraft papers. Paper could be made from soda pulps of the same wood as strong but not as tough and the yields of pulp were much less.

Chas. P. Fox: *Syrian Autoburning Limestone.*

Examination of a sample of Syrian self-burning limestone, obtained from U. S. Consul Whiting at Jerusalem, Palestine, and described by him in *Daily Consular Report* of July 21, 1911.

This rock belongs to the fossiliferous bituminous limestone formation of the Hauran district in the upper Jordan Valley.

In this section lime burning, on account of the quantity of raw material, quality of product and low cost of production, is an important industry.

Analysis of sample shows calcium carbonate, phosphoric acid, nitrogen, sulphur and organic matter, a portion of which is of asphaltic nature.

The original limestone has a fuel value equal to one fourth that of good coal. When properly prepared it forms a *compounding material* suitable for use in the production of black rubber goods.

The presence of notable quantities of plant food associated with the physical characters of the rock classifies it as an important soil maker, a fact proven by the rich grain fields of Syria.

Chas. F. Fox: *An Improved Laboratory Burner.*

A description, illustrated by photograph, of a useful attachment (combined wind shield and crucible support) for laboratory burners.

J. Culver Hartzell: *The Correlation of Chemical, Structural and Thermal Analyses of Steels.*

In this paper the author presents the subject from the viewpoints of pure and applied science. In a recent trip which occupied several weeks, the author made a study of testing laboratories and heat-treatment plants and was impressed with the necessity of a better correlation of laboratory results with works results. Refinement of laboratory technic must be maintained; but there is need of better recognition of the limits of refinement in the hardening-room and high-speed-steel furnaces. While the latter should be brought up to and maintained at their highest efficiency, the refinement of the laboratory should not be expected; but the instructions sent down from the laboratory should contain reasonable working limits compatible with the best practical results obtainable.

E. Lehman Johnson: *If the Chemists Manufactured Cotton-seed Meal.*

If chemists, familiar with the need of balancing rations, had the exclusive manufacture of cotton-seed meal, instead of turning out a product altogether too rich, too concentrated, for ordinary feeding of any kind, as the southern cotton-oil mills are doing, they would make it in more sensible, more scientific fashion, more nearly like the cereals, corn and oats.

To insist, as some states already do and the national government is trying to do, upon compelling a high protein or nitrogen content of cotton-seed meal (higher than linseed meal, for instance) is an arbitrary abuse of power, good for neither producer, manufacturer or consumer. All three of these classes should look to the chemist for guidance in this matter, not to old habit or prejudice.

Irving C. Allen: *The American Petroleum Society.*

Irving C. Allen: *Flash Testing.*

Horace C. Porter and O. C. Ralston: *A Study of the Oxidation of Coal and of the Process of Combustion.*

The rate of oxidation was studied for different kinds of coal at temperatures from 40° to 200° C. Large differences in rate were found which are in general parallel to the differences in inflammability and ease of ignition. The rapid increase of rate with rising temperature was shown. A study was made also of the products of oxidation, and evidence obtained which strongly supports the theory of the preliminary formation, in the early stage of combustion, of an addition complex of coal

with oxygen. This complex is unstable and decomposes by rise of temperature so as to form water, CO_2 and CO. Below 200° C. water is the principal product of the oxidation of coal. Carbon dioxide and carbon monoxide are formed in increasing amounts at 110° C. and above, by decomposition of the intermediate complex.

The bearing of the results on deterioration and spontaneous combustion, inflammability of coal dust, methods of analysis of coal, and problems of mine ventilation and mine fires is brought out.

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

S. L. Bigelow, *Chairman*

R. C. Wells, *Secretary*

R. C. Wells: *Observations on the Electrochemical Behavior of Minerals.*

It has been found that pyrite, which is a common constituent of most ore deposits, is capable of functioning to some extent as an unattackable electrode, so that chemical differences between solutions in ore deposits may be equalized through electrical action over appreciable distances as well as by direct mingling of the solutions. Such action would, however, require some sort of a liquid circuit in addition to the conducting mineral. A solution of sodium sulphide in contact with pyrite constitutes an anode combination of sufficient power to precipitate gold, silver, mercury and copper from their soluble salts upon a cathode of pyrite in an arrangement like a "chemometer." In fact, pyrrhotite and chalcocite in water alone suffice as anodes for the same purpose. The action of the more attackable minerals is due principally to their own solution-products so that the additional effects possible with unattackable electrodes are less marked.

Eugene C. Bingham: *Fluidity and van der Waals's Equation.*

Batschinski[3] has proved that the fluidity ϕ of an unassociated liquid is a linear function of its volume (v) only, up to the critical temperature, *i. e.*, $v = \omega + c\phi$, where ω is a constant which is the sum of the atomic constants, and c is a constant which may be calculated. Substituting this value into the equation of van der Waals we obtain a relation between the fluidity of a liquid and the temperature and pressure

$$T = \frac{pk}{R}\phi + \frac{p}{R}(\omega - b) - \frac{a/Rc}{\phi + \omega/c} + \frac{ab}{R(\omega + c\phi)^2}$$

and all of these constants may be obtained without further viscosity measurements. Hence it is theoretically possible to calculate the fluidity of any non-associated liquid as soon as its expansion coefficients are sufficiently well known.

It can be shown that the above formula works out admirably in practise. Since in ordinary viscosity measurements, the pressure is constant and the last term of the equation may be neglected, we have

$$T = A\phi + C - \frac{B}{\phi + D},$$

where A, B, C and D are constants. An equation of this form will reproduce[4] the observed fluidities of the 85 substances measured by Thorpe and Rodger with a mean deviation for no substance equal to 0.1 per cent. In fact for most substances D may be made equal to zero, and satisfactory results obtained with the simple formula

$$T = A\phi + C - B/\phi.$$

The measurements of Phillips[5] confirm the view that the ϕ, p, T curves are similar to the familiar v, p, T curves up to the critical temperature. Beyond the critical temperature ϕ does not increase as the pressure is lowered, as is true of the volume. This leads to interesting and hitherto unnoticed relations between "collisional" and "diffusional" viscosity.

E. C. McKelvy and F. A. Wertz: *The Solubility of Water in Hydrocarbons.*

The critical solution temperature in certain systems of two liquids varies greatly with small additions of moisture. Solubility curves were determined for the systems methyl alcohol-turpentine, methyl alcohol-ligroin and ethyl alcohol-kerosene, with the dry hydrocarbons. The curves showing the variation of the maximum with small additions of water were then plotted. The hydrocarbons being saturated with water at any given temperature, the critical solution temperature found gives from these curves the amount of water dissolved in the oil. Calcium chloride was found to be most effective in drying the oils without otherwise changing their composition.

L. M. Dennis and B. J. Lemon: *Electrolysis of Solutions of the Rare Earths.* (Lantern.)

Wilder D. Bancroft: *Action of Light on Copper Sulphate Solution.*

Wilder D. Bancroft: *Catalysis of Acetic Acid.*

E. C. McKelvy: *The Critical Solution Temperature and Its Use in the Estimation of Moisture.*

The variation of the critical solution temperature of two liquids on the addition of a third com-

[3] *Ann. Soc. d'encourag. sciences exper.*, Supplement, *3*, 1913.

[4] *Zeitschr. f. phys. chem.*, *66*, 238 (1909).

[5] *Proc. Roy. Soc. London*, *87A*, 56 (1912).

ponent has had very little application in analytical chemistry. The solubility curve of the system ethyl alcohol-kerosene has been determined and the curve, showing the variation of the maximum with small additions of water, plotted. The change for 1 per cent. is 17.05°, but the variation is not quite linear. With careful manipulation the critical solution temperature can be determined repeatedly to 0.01° and so may be used to indicate a change of less than 0.001 per cent. in the water content of the alcohol. If the moisture in the substance to be examined can be transferred to anhydrous ethyl alcohol by some suitable means, a very delicate quantitative method is at hand. Since ethyl alcohol forms a mixture of minimum boiling point containing about 5.5 per cent. water, all alcohols, containing less than this amount of water, will tend to distil off between 78.0° and 78.3°. Distillation of the moist substance with anhydrous alcohol would be effective for the transfer of the moisture. Standing with the alcohol at room or higher temperatures might answer with certain substances. The method has been used in moisture determination in coal, wool, cotton, starch, sugar and offers possibilities in the examination of food products, soap, gelatin, shellac, oils, various textiles, etc.

GEORGE A. PERLEY and G. F. LANE: *The Analysis of Basic Lead Sulphates.*

EDGAR T. WHERRY: *Variations in the Compositions of Minerals.*

The old definition of a mineral species as a definite chemical compound is, in the light of recent work, no longer tenable. Instead it should be: a natural substance whose chemical and physical properties are constant within certain limits which vary considerably from one case to another. Colloid minerals may vary by reason of adsorption; meta-colloids (colloids which have become crystalloidal) and crystalline ones by isomorphous replacement, solid solution and sub-microscopic intergrowth. The group of ferric phosphate minerals is discussed as an illustration.

PAYSON BARTLETT: *The Increase in the Oxidising Potential of Dichromate Ion on Platinum Caused by Certain Reducing Agents. An Improved Method for the Electrometric Titration of Ferrous Salts.*

Certain reducing agents increase the oxidizing potential of the dichromate ion on platinum by amounts up to two tenths of a volt. No other oxidizing agent was found which would give a similar effect.

The potential continues to increase up to the very endpoint of the reaction and is highest when the dichromate concentration is least. A final drop of 0.1 normal reducing agent often depresses the potential by half a volt.

The duration of the effect varies with the reducing agent used from a few seconds to many hours. Chlorides are fatal to the permanency owing apparently to a side reaction.

The phenomenon may be plausibly explained by assumptions of catalytic action.

An improved apparatus and method for titrating dichromate and ferrous salts, based on the phenomenon, is suggested.

When the endpoint of this reaction is determined with a ferricyanide indicator, 0.0003 gram excess of ferrous iron in each hundred cubic centimeters of solution is present when the blue color barely develops within thirty seconds.

W. S. HUBBARD: *Equilibrium between Pyridine, Silver Nitrate and Water.*

While working on a silver-plating bath where pyridine was used instead of cyanide, it was noticed that under certain conditions of concentration and temperature long silky, needle-shaped crystals separated out. Brewer[6] found that there were three well-defined compounds formed with pure pryidine and silver nitrate, but their description in no way resembles the one found in this case.

With 3 c.c. pyridine, 5 gm. silver nitrate and made up to 100 c.c. with water, the crystals form at 19.70° C. Using 4 c.c. of pyridine, they form at 25.35°, with 5 c.c. they separate at 27.35° and with 6 c.c. pyridine at 27.75°.

The exact composition has not been determined, but the method will be to determine the total nitrogen and nitrate nitrogen and then determine the silver electrolytically. The water can then be determined by difference or by drying in a desiccator since it thus loses its water of crystallization and becomes a fine powder. However, some of the pyridine might thus be lost.

PHILIP ADOLPH KOBER: *New Precipitants for Copper.*

Two new precipitants for copper are proposed which form very insoluble compounds of copper (less than .6 part in one million remain unprecipitated). These are amino acids, phenylglycin and normal amino caproic acid which may be useful in estimating Fehling's and other solutions for unreduced copper and in removing copper quantitatively from substances which interfere with its idiometric titration.

[6] *J. Phys. Chem.*, 12, 283.

E. W. Washburn and S. J. Bates: *The Electrochemical Equivalent of Iodine and the Value of the Faraday.*

H. C. P. Weber: *The Reduction of Chromium Chloride.*

T. W. B. Welsh and H. J. Broderson: *Anhydrous Hydrazine as a Solvent.* (Presented by A. W. Browne.)

The solubility of 120 elements and compounds in anhydrous hydrazine was studied. Of the metallic elements employed, the alkali metals are the only ones appreciably acted upon and dissolved. The solubility of the halogen compounds increases with increase in the atomic weight of the halogen. The chlorides of the alkali metals are the least soluble. Carbonates and oxides are, as a rule, insoluble. Nitrates are generally soluble. Sulphates and sulphides are insoluble. Ammonium compounds are soluble with the exception of the tertiary phosphate. The solution of ammonium salts is accompanied by *hydrazinolysis* with evolution of ammonia. A large number of compounds dissolve, and at the same time react with the solvent.

T. W. B. Welsh and H. J. Broderson: *Chemical Reactions in Anhydrous Hydrazine.* (Presented by A. W. Browne.)

Metathetical reactions take place between soluble salts of zinc, or cadmium, and hydrazine sulphide, with formation of the metallic sulphides. In fact, solutions of these salts in anhydrous hydrazine may be titrated with solutions of hydrazine sulphide, using the brownish-yellow color of the latter as indicator. By the action of the *hydrazo-base,* sodium hydrazide, upon zinc chloride in hydrazine solution, a solid which is in all probability zinc hydrazide, is precipitated. Hydrazo-bases are neutralized in hydrazine solution by hydrazine salts, which under these conditions act as acids. For example, sodium hydrazide reacts with hydrazine chloride, yielding sodium chloride and hydrazine. Metallic sodium will precipitate metallic cadmium, zinc and iron, from solutions of their salts.

T. W. B. Welsh: *Electrolysis of Solutions of Sodium Hydrazide in Anhydrous Hydrazine.* (Presented by A. W. Browne.)

Solutions of sodium hydrazide (prepared by the action of either sodium amide or metallic sodium upon hydrazine) in anhydrous hydrazine have been electrolyzed, in absence of air and moisture, under such conditions as to permit measurement and analysis of the gases evolved at the electrodes. In general nitrogen and hydrogen were obtained at both electrodes. For each gram atom of copper deposited on the coulometer cathode, from 1.1 to 1.5 gram atoms of nitrogen were liberated at the anode when the electrolyte was dilute, and from 2.1 to 2.6 when the concentration was higher. A blue color due to metallic sodium was in some experiments transitorily observed at the cathode. A characteristic yellow coloration was (reversibly) obtained in the neighborhood of the cathode.

A. R. Hitch: *Electrolysis of Silver Trinitride in Liquid Ammonia.*

A. R. Hitch: *Thermal Decomposition of Various Trinitrides.*

Harold Eaton Riegger: *The System Hydrazine Trinitride, Hydrazine.* (Presented by A. W. Browne.)

It has been found possible to prepare hydrazine trinitride (first prepared by Curtius) by each of three methods: (*a*) Interaction of anhydrous hydrazine and ammonium trinitride, (*b*) interaction of anhydrous hydrazine and anhydrous hydrogen trinitride, and (*c*) interaction of alcoholic hydrazine and ethereal hydronitric acid. A convenient method for the analysis of the compound has been formulated, and certain of its properties and reactions have been studied, including the behavior of the substance when heated in a sealed tube to 100°. The substance is very soluble in anhydrous hydrazine, and soon deliquesces when exposed to hydrazine vapor. A study of the solubility (T, X) curve for the system hydrazine trinitride; hydrazine yielded results that point toward the existence of a monohydrazinate of the formula $N_2H_5N_3 \cdot N_2H_4$, and to the probable existence of at least one higher hydrazinate.

W. J. Marsh: *Action of Various Oxidizing Agents upon Hydrazine in Liquid Ammonia Solution.*

The behavior of free hydrazine in liquid ammonia at —33° toward potassium permanganate, manganese dioxide, mercuric oxide (yellow), ammonium persulphate, sodium peroxide, ferric oxide, potassium chlorate, potassium iodate and ammonium perchlorate, respectively, has been studied with the aid of a modified nitrometer. All but the last three of these substances oxidize the hydrazine more or less rapidly, with formation of nitrogen and water as the oxidation products. Potassium permanganate is quantitatively reduced to manganous hydroxide and potassium hydroxide. In several cases the gas was evolved in two distinct

stages, the second stage occurring at a temperature somewhat above —33°. This may be attributable to the decomposition in successive stages of the oxidizing agent used, or possibly to the formation and subsequent decomposition of certain complex hydronitrogens as unstable intermediate products.

FRITZ FRIEDRICHS: *Critical Phenomena in Binary Systems.* (Presented by A. W. BROWNE.)

FRITZ FRIEDRICHS, A. E. HOULEHAN and L. J. ULRICH: *The System Ammonium Sulphate, Ammonia.* (Presented by A. W, BROWNE.)

FRITZ FRIEDRICHS: *The System Mercuric Chloride, Ammonia.* (Presented by A. W. BROWNE.)

L. J. ULRICH: *The System Ammonium Iodide, Ammonia.* (Presented by A. W. BROWNE.)

G. J. FINK: *The System Ammonium Chloride, Ammonia.* (Presented by A. W. BROWNE.)

G. J. FINK: *The System Copper Sulphate, Ammonia.* (Presented by A. W. BROWNE.)

A. S. YOUNT: *The System Silver Trinitride, Ammonia.* (Presented by A. W. BROWNE.)

J. W. TURRENTINE: *The Structure of the Trinitride Radicle.*

SYMPOSIUM ON PHOTOGRAPHIC CHEMISTRY

This symposium was held at Kodak Park. Papers were presented as follows:

GEO. A. PERLEY: *The Production of Direct Photographic Positions.*

P. G. NUTTING: *Practical Sensitometry.*

Photography sensitometry is the determination of the relation between blackening and exposure. Blackening is measured as density $D = -\log$ transmission. Exposure is properly in ergs per sq. cm. of a specific wave-length but in meter-candle-seconds involving properties of the eye. The Hurter and Driffield curve, density against log exposure gives the two chief characteristics—speed and contrast sensibility. Plates are fast or slow, hard or soft working according to the shape of this curve.

Works tests are made by printing through a tablet of gray and colored squares of graduated density. Laboratory tests are made by exposure to a standard white light behind a rotating sectored disk giving exposures of 1, 2, 4, 8 . . . 256, M-C-S. Densities are measured on a special photometer. High precision sensitometry requires many refinements of coating, exposure, development, etc.

S. E. SHEPPARD: *Some Applications of Quantitative Absorption Spectroscopy in Chemistry.*

Making use of the relations:

(i) $I_\lambda = I_0 a^{cd}$ (Beer-Lambert law), where I_λ = intensity of monochromatic light wave-length λ transmitted by an absorbing layer of thickness d cm., and of concentration c in grammes per liter, I_0 = intensity of light incident on same, a = a constant, the transmission-coefficient.

(ii) $M = C/a$ (Vierodt's equation), where M = molecular absorption ratio,
C = concentration in gram-molecules per liter,
a = transmission-coefficient of (i).

Then the absorption of light can be determined quantitatively in regard to both color (wave-length of light waves) and concentration of reacting molecules. The principal applications considered were as under:

(*a*) Analytical determination of amounts of dye-stuffs and colored salts in solutions.

(*b*) Technical: adjustment of ray-filters.

(*c*) Theoretical: application to problems of molecular constitution, of "solutions" and of photo-chemical change.

L. A. JONES: *Some Notes on the Cylindrical Acetylene Flame as a Standard of Light.*

A good reliable standard light source is a necessity in photographic sensitometry. The old-style acetylene flame is not very satisfactory for this purpose, on account of its sensitiveness to air currents and the liability to parallax errors. A newer type of standard acetylene burner designed by Dr. Mees and Dr. Sheppard gives a cylindrical flame much more steady and reliable than the flat flame.

Careful photometric measurements made on this improved burner show that when properly adjusted the intensity of light is constant even when the gas pressure varies considerably. The results indicate also that with proper care in construction, especially in the width of slit used as screening diaphragm, different burners can be made that will give the same light intensities to within 3 or 4 per cent.

The investigation is not complete as yet, but unless unexpected difficulties arise, this form of burner will undoubtedly be found very satisfactory as a standard light source for sensitometric work.

ORIM TUGMAN: *The Sensitiveness Curves of Photographic Plates Exposed to X-Rays.*

According to the equation given by Hurter and Driffield for the relation between the exposure and the development density in photographic plates the density of a plate exposed to X-rays should be directly proportional to exposure because the ca-

pacity of the film to X-rays is negligibly small.

A series of exposures of three kinds of plates (Seed 23, 30 and X-ray) to light and X-rays have been made to determine this point. In all the fifteen exposures to X-rays the curves showing density against log exposure were practically similar to the curves obtained by light exposure. The equation

$$D = \gamma \ (\log E - \log i)$$

was found to fit the straight part of the curves as well as for light curves.

A. S. McDANIEL: *The Theory of the Acid Fixing Bath.*

The amount and nature of free acid which can be added to a thiosulphate fixing bath is shown to be dependent upon the equilibrium conditions of either or both of the following reversible reactions, one of which takes place between ionized, the other between undissociated molecules:

(1) $S_2''O_3 + H \cdot \rightleftarrows HSO_3' + S,$

(2) $Na_2S_2O_3 + 2HX \rightleftarrows 2NaX + N_2SO_3 + S.$

According to equation (1) the absolute concentration of the hydrogen ions can be increased only by increasing the concentration of the HSO_3 ions at the same rate. Similarly, according to equation (2) the absolute concentration of acid can be increased only by keeping the ratio of the concentration of H_2SO_3 to HX above a certain definite limit, depending upon the solubility of sulphur.

In practise these conditions are fulfilled by adding sulphurous acid or a mixture acid or a mixture of sulphite and acid to the bath.

WILDER D. BANCROFT: *The Latent Image.*

WILDER D. BANCROFT: *Theory of Developer.*

G. B. FRANKFORTER and W. KRITCHEVSKY: *The Action of Chloral and Bromal on the Polycyclic Hydrocarbons in the Presence of Aluminium Chloride.*

G. B. FRANKFORTER and E. B. DANIELS: *The Action of Aluminium Chloride on Aliphatic Ethers.*

DIVISION OF FERTILIZER CHEMISTRY

Paul Rudnick, *Chairman*

J. E. Breckenbridge, *Secretary*

PAUL RUDNICK: *Chairman's Address. Fertilizer Chemistry. A Report of Progress.*

L. A. WATT and W. T. LATSHAW: *On the Use of Alundum Crucibles in the Determination of Phosphoric Acid.*

H. W. HILL and W. S. LANDIS: *The Analysis of Complete Fertilizers Containing Cyanamid.*

PAUL RUDNICK and W. L. LATSHAW: *On the Preparation of Neutral Ammonium Citrate Solution.*

SECTION OF INDIA RUBBER CHEMISTRY

D. A. Cutler, *Chairman*

Dorris Whipple, *Secretary*

D. A. CUTLER: *Chairman's Address. Crude Rubber.*

G. H. SAVAGE: *Some Refinements of the Ignition Method for the Determination of Rubber in Vulcanized Goods.*

WATER SEWAGE AND SANITATION SECTION

Edward Bartow, *Chairman*

HARRY P. CORSON, *Secretary*

EDWARD BARTOW and H. P. CORSON: *Manganese in Illinois Waters.*

The city supplies of Mt. Vernon and Peoria, Ill., contain manganese which has caused serious incrustation in pipes. The Mt. Vernon supply contains .5 part per million of the element while the wells of the Peoria supply contain from .02 to 1.2 parts per million of the element. Samples of incrustation examined contain as high as 38 per cent. of manganese.

EDWARD BARTOW and CLARENCE SCHOOL: *A Comparison of a Calcium Lime with a Calcium-Magnesium Lime for Water Softening.*

Experiments show that during the various stages of water softening there is a difference in the action of a calcium lime and a magnesium-calcium lime. Complete softening depends upon the amount of available calcium oxide which the lime contains.

EDWARD BARTOW and CLARENCE SCHOOL: *The Order of Reactions during the Softening of Water with Lime.*

CHARLES BASKERVILLE: *Ventilation of the Schools of New York City.* (Illustrated.)

FRANK E. HALE and W. MELIA: *Winkler's Method for the Determination of Oxygen in Water; the Effect of Nitrite and its Prevention.*

H. W. REDFIELD and C. HUCKLE: *A Comparative Study of Methods for Determining Sulphur in Peptone.*

Various methods for determining the total sulphur in peptone and for determining a part of the sulphur only have been compared.

For total sulphur the Liebig-Koch method has been found to give the most accurate and most consistent results in peptone; while for determining the easily oxidized part of the sulphur, digestion with a saturated solution of potassium chlorate in nitric acid has proved most valuable.

H. W. REDFIELD and C. HUCKLE: *The Determination of Sulphur in Certain Culture Media.*

A study has been made of the amount of total

sulphur broken down in simple peptone media by the so-called putrefactive bacteria, of the forms of sulphur most readily used by them and of the forms in which the sulphur exists after the action of the bacteria, whether as fixed sulphur, or as loosely bound sulphur, or as easily oxidized sulphur, or as a volatile sulphur compound such as hydrogen sulphide, when culture flasks of different size and shape were used and when air or carbon dioxide was passed over the cultures.

E. M. CHAMOT: *The Value of Testing for Hydrogen Sulphide Production in the Bacteriological Examination of Potable Waters.*

E. M. CHAMOT and H. W. REDFIELD: *A Study of the Best Conditions for Hydrogen Sulphide Production in Peptone Media.*

The method for the detection in water of the bacteria producing hydrogen sulphide has been studied in a systematic manner as regards the concentration of possible ingredients, and a culture medium has been devised by the use of which the time required in which to get evidence of the presence of these organisms has been greatly reduced.

The method furnishes a means of detecting certain organisms which do not produce gas in lactose media, but which are found in sewage-polluted water.

E. M. CHAMOT and R. C. LOWARY: *The Influence of the Composition of Carbohydrate Culture Media on the Amount and Character of the Gases formed by Fecal Organisms.*

E. M. CHAMOT and C. M. SHERWOOD: *A Study of the Stokes Neutral Red Reaction.*

J. CULVER HARTZELL: *Further Notes on Standards of Potable Waters.*

In this paper the author states that he has collected further data on the necessity for regional standards of potable waters, and that the feeling is growing that standards are not only possible and desirable, but necessary.

ATHERTON SEIDELL and PHILIP W. MESERVE: *The Determination of Minute Amounts of Sulphur Dioxide in Air.*

The amounts of sulphur dioxide which it was desired to determine varied from about 1 to 15 parts per million, which is about the concentration just detectible by the odor. Experiments showed that at this dilution, various modifications of the iodine titration methods, involving the use of an excess of iodine and back titration directly or with an excess of thiosulphate and then to appearance of the blue starch color with iodine, were impractical on account of the variability of the end point when approached in opposite directions. It was found that satisfactory results could be obtained by adding about 5 c.c. of water containing starch paste to the 2,500 c.c. bottle containing the sample and titrating to appearance of the blue starch color with $N/1{,}000$ iodine. A correction for the blank determination in the bottle containing air free from sulphur dioxide, and one for the apparent incompleteness of the reaction at this dilution must be applied. With these corrections for a 2,500 c.c. bottle, 1 c.c. of $N/1{,}000$ iodine corresponds to 4.1 parts SO_2 per million. On account of the rapid oxidation of SO_2 to SO_3, even in bottles as dry as can conveniently be obtained, it is necessary to make the titrations within a short time after collecting the samples. When relatively minute amounts of SO_2 are liberated in rooms and the air actively stirred, less than one half the calculated percentage in the air has so far been found. The complete disappearance of the liberated SO_2 may occur in less than one half hour, depending upon the amount of moisture, nature of walls, etc.

J. W. SALE and W. W. SKINNER: *Comparison of Methods for the Determination of Dissolved Oxygen.*

A comparison of the Winkler and modified Levy methods with the gasometric method for the determination of dissolved oxygen indicates that in pure and moderately polluted saline waters the Winkler method gives accurate results while the Levy method gives results that are too low. The Winkler method also gives closely agreeing results in duplicate and triplicate determinations on such waters, for the most part within .02 c.c. oxygen per liter. Only that modification of the Levy method in which sodium carbonate is used to precipitate the iron salts was compared.

W. D. COLLINS and W. W. SKINNER: *The Quantitative Use of the Spectroscope in Water Analyses.*

By careful attention to details of manipulation described in the paper quantitative results for lithium and potassium may be obtained by use of the spectroscope in very much less time than is required for separation of the alkalies in a water analysis. The errors may be 5–10 per cent. of the amounts determined. The results in connection with other quickly made determinations make possible the furnishing of a fairly complete water analysis with a comparatively small amount of work.

F. L. RECTOR: *Longevity of B. Typhosus in Water.*

CHARLES L. PARSONS,
Secretary

SCIENCE

FRIDAY, NOVEMBER 21, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE STRUCTURE OF THE UNIVERSE[1]

I HAVE been asked to address you on the structure of the universe. The title is ambitious, and I fear that what I have to say on the subject will be sadly in disproportion with what some of you will be led to expect by this title.

It will, however, I hope, give you a glimpse of what astronomers now-a-days are attempting to do, in order to penetrate somewhat into the mystery of the starry sky.

The problem, as I take it, is a double one. We have, first, the structure of the universe as it is at the present moment; and this problem is, in the main, no other than finding the star distances, because the star directions we can readily ascertain.

We have, second, the problem of the history and evolution of the system.

The time at my disposal being so short, I must confine myself to one of the two. At the present moment, undoubtedly, the first is the more promising one, owing to the recent discovery of star-streaming. Furthermore the history of the system during the past ages, ages to be counted by millions, probably hundreds of millions of years, is and perhaps forever will remain enshrouded in much mystery. Still I have thought that the second problem, that of the evolution of the system, may, perhaps, be the more suitable subject for the present lecture.

You will all, of course, understand, without my saying anything to the purpose, that what we have to expect can not well be anything else than a few more or less

[1] Address delivered before the National Academy of Sciences, April, 1913.

probable inferences about the course of events that have made our system what it is.

Some additional considerations might easily have been added, but as I have had to give up the idea of giving a general review of what has been done, I thought it might be as well to confine myself to just a few illustrations of the kind of speculations that we are being at present led to; and as these speculations, mainly or wholly, depend on the theory of star-streaming, it may be well to begin by saying a few words about that theory.

In order to get a clear idea of what is understood by the phenomenon of star-streaming: Imagine two clouds or swarms of stars, at first wide apart in space; imagine that the stars within each cloud move in all directions, indiscriminately, pretty much as do the molecules of a gas, and let us call this motion in the cloud the "internal motion." In fact, imagine two immense gas bubbles, the molecules of which will be our stars.

Now, imagine these two clouds or bubbles to be moving in space, and let that motion bring the two gas bubbles together, so that they will penetrate each other. Then imagine that we, the spectators, are in that part of the universe where the two bubbles have intermixed, and finally imagine that we, the spectators, have a motion of our own.

What we shall see of the motion of the individual gas molecules will very nearly correspond to what we see of the motion of the stars actually going on in the sky.

Now, what is the appearance of such a motion? Had the molecules in each gas bubble no internal motion, that is, had they no other motion than the common cloud-motion of all the molecules together, as a whole, then of course what we would see would be this: We would see two immense streams of stars, all moving in perfectly parallel lines, with what, linearly, must be perfectly equal velocity.[1] If, however, the internal motion is not zero, then, of course, what we shall see will be more or less different. The internal motion gives to each molecule, besides the motion which is common to the whole of the bubble, an additional individual motion, which will make the total motion of the several molecules diverge more or less from perfect parallelism and perfect equality. Instead of seeing two streams with perfectly parallel motions, we must now see the stars *in the main* parallel to two directions, but there will be deviations—small deviations will be frequent, greater deviations will be rare, and very great deviations will be decidedly exceptional. The motion of the two individual bubbles will still be clearly discernible.

Now this is indeed what we observe in the sky. We recognize in the star motions two clearly defined *preferential* motions. These directions make an angle of about one hundred degrees. The stars are not moving all in these directions. Small deviations are frequent; greater deviations are somewhat rare; very great deviations are decidedly exceptional.

We may say that all investigations made since the first announcement of star-streaming in 1904—investigations based on very different materials—all agree in the establishment of these two preferential directions of motion among the stars. We find them in the brighter stars; we find them in the fainter stars; they show in the swift-moving stars; they show in the slow-moving stars. They betray their existence in the radial motions as well as in the motion at right angles to the visual ray.

In the *interpretation* of the facts, how-

[1] Throughout the address the motions are to be understood as relative to the sun.

ever, there is a difference. *Our* representation by the two independent star clouds is one of them. Whether this interpretation is the correct one, is a question of evolution of the system and will have to be considered presently.

Our conclusion will then be in favor of the two-cloud theory; and so, for the sake of greater clearness, I will provisionally continue to use this representation. In reality what will be advanced will not be changed, or but slightly, if we simply start from the observed facts.

In the study of the history of the system, we start from what we know, or think we know, about the evolution of the separate stars.

The stars have been classified by Secchi into four spectral classes. We have at present far more elaborate classifications, but for the present purpose Secchi's classification will do. The stars of the fourth type are so few in number that we may, for the present, neglect them. Part of the first type has later on been separated from the rest; they show the helium lines in their spectrum and are now generally brought to a separate class, the class of the helium stars.

We will thus consider the four classes: the helium stars, those of the first, second and third types—helium, first, second and third—in which the bulk of all the stars with known spectrum are contained.

Now, there is much evidence to show that this classification is a natural one. I mean that this order is really an order of evolution; the helium stars being the stars of recent birth; while we get to older and older stars as we pass from the helium stars to the first, from the first to the second, and from the second to the third type. I will adopt this order of evolution in what follows, although well aware of the fact that all astronomers do not agree with me. I feel justified in this course, not only because I think it is the opinion of the great majority of our eminent spectroscopists, but also because the very facts which I wish to put before you about star streaming strongly confirm it.

When we wish to penetrate into the history of the system, it seems natural to investigate the problem of star streaming separately for those four classes of stars in the order of their evolution. There are some difficulties, mainly the consequence of scantiness of material. Still, however, even now it has been possible to carry the investigation through in such a way as to establish a couple of facts, and to give clear indications of others. Of these I will consider only the two following, about the reality of which I think there can hardly be left any doubt.

First, the older the stars, the greater the internal velocity, and

Second, the older the stars, the richer the second stream, at least in comparison with the first stream.

I wish to consider some of the inferences to which these facts lead us. And in the first place, these facts at once lead us back to the question just now mentioned, about the order of evolution of the individual stars. For this regularity in the increase both of the internal velocity and of the richness of the second stream exist only *if we adopt* for the order of evolution either the order, helium, first, second and third, or the exact verse order, third, second, first, helium, and in no other arrangement.

Therefore, with the same right that we expect that all the properties of the stars will change with age, gradually, and not per saltum, with that same right, I think, we conclude that the order of evolution must be helium, first, second, third, or the exact reverse. That it is not just the reverse is proved by other facts we can not now consider.

We thus have strong confirmation here of what, on totally different grounds, is pretty generally considered as the order of the different ages in a star's life.

But to proceed: As the younger the stars, the smaller their internal motion, it follows at once that from whatever matter our youngest stars—the helium stars—may have been evolved, that matter must, in all probability, have still smaller internal motion. Let us call this matter *primordial matter.* As the internal velocity of the helium stars is already so very small we come to the conclusion that primordial matter must practically have hardly any other motion than the motion of the cloud to which it belongs.

There is more. According to the second of the observed facts, the second stream, which is rich for the older stars, is much poorer for the younger ones; it almost dies out in the helium type stars. We must expect, therefore, that for primordial matter there will practically be no second stream or second star cloud.

Therefore, finally, we must expect that the particles of primordial matter will all move in practically parallel lines, and that in the direction in which all but a very few of the helium stars move, and with the same velocity.

Now it is a very general notion that it is from the nebulæ that the stars are formed. Therefore that what we called primordial matter would be nothing else than the matter of the nebulæ. What precedes gives us the means of testing the notion by observation. What then does observation show?

The number of available data is as yet extremely small. The determination of what we call astronomical proper motion of these very ill-defined objects is extremely difficult, and has been up to the present time invariably unsuccessful. For the determination of the radial velocity by the spectroscope, the faintness of the nebulæ is a serious obstacle. The consequence is that, as yet, we know the radial velocity of only fourteen of these objects in all. Still, even this limited number is decisive in showing that there can be no question that the real motions of these objects are approximately parallel to the motion of the helium stars, or even parallel to any fixed direction whatever. Their velocity, moreover, is exceedingly unequal. Must we conclude that the nebulæ are not the birthplace of the stars? It may seem so.

Meanwhile let us not go too fast. There are nebulæ and nebulæ. It so happens—and there is ample practical reason for it—that with one exception observation of radial velocity has, up to the present time, been confined to what we call the planetary nebulæ—elliptical or round nebulæ—which show an appearance remotely like that of a planetary disc. Herschel saw in them a likeness to what, according to Laplace's cosmogony, must have been the primitive stage of our own planetary system and so imagined that these planetary nebulæ must be the birthplace of the stars.

According to what precedes, this view seems now untenable. The planetary nebulæ can not be the birthplace of the stars. If they were, they would show the parallel and equal motion of practically all the helium stars. Their motions, on the contrary, are extremely unparallel and unequal, and we must rather assign these objects a place at the end of the order of evolution than at the beginning.

We may, perhaps, see an independent confirmation of this view in the stars called temporary stars, but time will not permit me to pursue the argument further.

As I said just now, there is one nebula for which the radial velocity has been determined which is *not* a planetary. This

exception is the well-known Orion nebula, which is classified under the irregular nebulæ. May not then these irregular nebulæ give birth to the stars?

It turns out that this one object has exactly the radial velocity of the first stream helium stars; that is, we find exactly the motion we must expect in this nebula, if it were the birthplace of stars. We shall not, of course, on this single fact base far-reaching conclusions; but we have a right, in my opinion, to say that here is a fact that singularly strengthens what had already been concluded from other facts.

We see, moreover, that the observation of the radial velocity of other irregular nebulæ must, ere long, furnish us with a crucial test of the theory.

There is another problem involved in our observations which might seem to be of no less importance than the one just mentioned. How have we to explain the fact that the internal velocity of the stars gradually increases with age? The astronomer who, in the study of the motion of the heavenly bodies, has found hardly a trace of any other force than gravitation will naturally turn to gravitation for such an explanation. It really seems a necessity that, under the influence of their mutual gravitation, bodies, which at the outset have little or no relative motion, must get such a motion; they must come to fall toward each other, and this velocity, up to a certain limit at least, must increase with time.

Thus far, there is no great difficulty. But now let us look farther back in time, back to the time in which the stars had not yet been formed, in which matter was still in its primordial state. If it be true that mutual attraction of the stars has generated such an enormous amount of internal motion in the time needed by the stars to develop from the helium type to the second and third type, how have we to explain the fact that we find that same matter nearly at rest at the first stage of evolution at which we meet it? How have we to explain that in pre-helium ages gravitation has produced no effect?

He who believes in the creation of matter at a finitely remote epoch may find no difficulty in the question; but to him who does not, it is simply astonishing to see matter behaving as if there were no gravitation at all. What may be the explanation? Is there no gravitation in primordial matter, or is there another force exactly counterbalancing its effects?

I shall offer no solution. I simply wish to point out that here is a problem which must be interesting to the physicist no less than to the astronomer.

Passing now to other inferences, I wish to draw your attention to a question already alluded to: does the observed fact of the preference of the star motions for two definite directions lead us with necessity to the assumption that our system has been formed by the meeting of two independent star clouds? Or is it still possible, and in that case more plausible, to explain it without sacrificing the unity of the system? In other words, is our universe a dual system, or is it one unit?

Suppose[2] a very elongated system of stars which are originally at rest; now let these be left to their mutual attraction. It is evident that the stars, in opposite parts of the cloud, will begin to fall towards each other. Two streams will be set up, opposite in direction, approximately parallel to the axis of the cloud, though in no wise absolutely and exclusively so. In other words, we get two preferential directions of motion. There is no real difficulty in the fact

[2] The following supposition was first considered in a lecture held at Harlem in 1906 ("Programme de la Soc. Holl. des Sc. pour 1906," p. liv).

that they are exactly opposite, whereas the streams observed in the sky make an angle of about a hundred degrees. For opposite streams, viewed from a self-moving body, as in our earth, will appear to make an angle and we can readily determine the earth's motion in such a way as to bring us in perfect harmony with observation. Thus far no objection. But there are further consequences.

In an elongated universe, as here supposed, *both* the mean longitudinal motion (what in this lecture was called the stream motion) and the deviations therefrom (the internal motion) must gradually increase, beginning with velocity *zero*.

Now as to the internal velocities, this is exactly what we find by observation. Do we find the same for the stream motion? By no means.

Recent Mt. Wilson observations have enabled us to derive at least a pretty reliable value of the relative stream velocity for the first type stars. For the helium stars we can as yet only assign a limit which the relative velocity of the two streams must exceed. For the older stars we have had reliable information for some time.

All these determinations show, contrary to what takes place with the internal motion, that the relative velocity of the two streams or clouds does not change, or does not change very much, with age. It certainly is not nearly vanishing for the helium stars. It seems to me that this consideration is fatal to the present explanation.

Professor Schwarzschild has developed a different theory, which also leaves the universe a unit; but this theory too, elegant though it be, can not, I think, be maintained. Among other things, we have, as a main objection, the fact—which was not known at the time Professor Schwarzschild proposed his theory—that the richness of the two streams is not the same for stars of different age. The tacit assumption is made, and must be made, in Schwarzschild's theory, that the two streams have the same number of stars. Now, this may be more or less approximately true of the stars of the second and third types, for the first type the number of stars in the second stream can not be much different from *one third* of that in the first stream. For the helium stars it must not be a *tenth*. The second stream is so poor here that it has been altogether overlooked till quite recently.

The conclusion to be drawn from all this seems obvious. It would seem that we are driven to the theory assumed here, from the first, the theory of the two-star clouds, which, owing to their initial velocity, have come to meet and intermingle in space. It must be confessed, however, that in this theory also there remain some hard nuts to crack. Until we succeed in this it seems unsafe to claim any great certainty for the theory, and it seems preferable to put it forward as the hypothesis which, for the time being, best fits the observed facts.

There remains to be considered the question how to explain that the second stream or cloud hardly contains any helium stars.

There is something in the small local star-groups which may help us. Everybody knows the group of the Pleiades. There can be no doubt that the bright and many of the faint stars that we see in this part of the sky are really near together in space and not merely near the same visual line, the one far behind the other. They undoubtedly form a physical system, and must have had a common origin. At present we know several of such local groups, among them the Hyades, the Ursa Major group, and we may perhaps add the great Scorpius-Centaur group.

Now, in these local groups, we find,

amongst others, two very remarkable facts. The first is that, ignoring a few, though significant exceptions, if the stars of such groups are arranged in the order of their brightness, we find that they are at the same time approximately arranged in the order of the spectral classes. As an instance, take the Scorpius-Centaur group. We find that the very brightest stars are of the earliest helium type; the somewhat fainter ones are of the older helium type; the next fainter ones are of the next stage in the stellar life, or the first type. If we can not follow the series further on to the second and perhaps the third type, this is probably due to our lack of knowledge of the fainter stars belonging to the group. In the Pleiades, where we have a somewhat more extensive knowledge of the fainter stars, we can follow the series at least until in the middle of the second type stars. It follows from this that in all these groups, what there is of helium stars can not be overlooked, for they all are of the very brightest stars, and our knowledge of the brightest stars is pretty complete.

Notwithstanding this—and this is the second remarkable fact, the fact that bears directly on the question in hand—we find not a single helium star, neither in the Hyades nor in the Ursa Major group. The stars in these groups show the same gradual change of spectrum with the brightness, but instead of beginning with the earliest helium stars, the series begins abruptly with the second stages of a star's life. In the Pleiades the series begins somewhat earlier; still here too there is not a single star of the earliest helium type. It is only in the Scorpius-Centaur group that we find the complete series.

Our second stream, therefore, behaves much as do the loeal groups of the Hyades and Ursa Major. The explanation must, in all likelihood, be the same in both cases.

How, therefore, does it come to pass that in such groups as those of the Hyades and the Ursa Major, the helium stars are absolutely wanting?

For those who, as I did in this lecture, adopt the view of the order of evolution as helium, first, second, third type, there can be no question but that the stars which we now see are first type stars, must in past ages have been helium stars.

Therefore, such a group as the Hyades, which now-a-days does not contain any helium stars, but which contains first type stars, must in past ages have contained the helium stars in great numbers. Going back in time still further, these helium stars must have been evolved from some primordial matter, probably some nebulous matter. Therefore, in a remote past the groups of the Hyades and Ursa Major must have been full of nebula. As far as I know there is no trace of nebulosity now.

There thus must have been an epoch in the past that nebulous matter was exhausted, had probably all gone into the formation of stars. Since that time evidently there could be formed no more helium stars; and as the helium stars that had been formed developed gradually into first type stars we see the necessity of a time in which the groups must not contain any more helium stars.

Therefore, finally, our answer to the question: how does it come to pass that in the second stream or cloud we find hardly any helium stars, would be: because since some time nebulous matter must have been exhausted in this cloud.

As to the first stream or star cloud, we similarly conclude that the nebulous matter must not yet have been exhausted, or if so, only at a very recent period.

It has been my aim to show, *not* that much has been done, but that there is a beginning; *not* that we have entered far into

the promised land, the land lying open to the human view, so temptingly since the first man looked up to the sky, but that a few pathways are being mapped out, along which we may direct a hopeful attack. Our problems take a more definite form, and even though we were never to solve them completely, let us remember the words of the poet:

> If God held in His right hand all truth, and in His left nothing but the ever ardent desire for truth, even with the condition that I should err forever, and bade me choose, I would bow down to his left, saying, "Oh, Father, give; pure truth can be but for Thee alone."

J. C. KAPTEYN

BLOOD PARASITES[1]

YOU will remember that Mephistopheles, when he insists upon the bond with Faust being signed with blood, says, "Blut ist ein ganz besondrer Saft" (Blood is a quite special kind of juice). Goethe would probably not have used the word "Saft" had he been writing "Faust" to-day instead of in 1808, for at that time the cellular elements of the blood—although they had been seen and described by Leeuwenhoek in 1686—were believed to be optical illusions, even by so distinguished a person as the professor of medicine of that time at the Sorbonne. The incredulity of scientific men as to what they see is proverbial and astounding, fortunately; but it is probably because science is really quite sure of nothing that it is always advancing.

I have the privilege this evening of trying to show you the barest outlines of our present knowledge of the parasitology of the blood. It is a subject of great practical and economic importance, as many grave diseases of man and beast are caused by these parasites, which, on account of their minuteness, enormous numbers and very complex life-histories, are very difficult to eradicate or to deal with practically. On this account there is a good deal of the enthusiasm of the market-place mixed up with this subject, which, although a new one, has advanced with great rapidity, and has revolutionized pathology and medicine as far as possible. From our point of view it began in 1880 with the discovery by Laveran, in the military hospital of Constantine, of the parasite which causes malaria. This caused the protozoa, to which order most of these parasites belong, to oust bacteria from the proud position they then occupied of being the cause of all the ills we have to bear, and to reign in their stead; not an altogether desirable change; for when you have seen what I shall show you, you will agree with me that sufficient unto life is the evil thereof. It has had all the disadvantages of a new subject, and since that time floods of work have been poured into journals, annals, proceedings, etc., some of it of the best, with much of it that is indifferent, temporary and bad; so that at times it seems as if this branch of science were in danger of being smothered in the dust of its own workshop, or drowned in the waters of its own activity. We do not, nowadays, keep our ideas and scraps of work to ourselves until they are either established, or, as is more likely, dissipated, so we have a huge mass of what is called "literature," filled with many trivial, fragmentary and doubtful generalizations, many of which we have with pain and trouble to sweep into the dustbin: nature's blessed mortmain law taking too long to act. You remember Carlyle complained—to use a mild term—of Poggendorff's "Annalen," and I feel sure that, if he had had to study blood parasites now, he would have said that it was a much over-be-Poggendorffed subject. Blood parasites are afflicted, too, with ter-

[1] Abstract of a lecture before the Royal Institution of Great Britain, May 2, 1913.

rible names, and with large numbers of them; some have as many as ten or even fifteen different names, perhaps on the Socratic principle, that naming saves so much thinking. And they are in Latin, too, so that the terminology of this subject is a perfect museum of long Latin and hybrid-Latin names. The terminology generally of our later biology is, as one has said, "the Scylla's cave which men of science are preparing for themselves, to be able to pounce out upon us from it, and into which we can not enter." This will be my excuse if I should use words you do not understand.

I will just remind you of the structure of the blood, that it consists of an extraordinarily complex fluid—the plasma—which holds in suspension living cellular bodies, called cells or corpuscles. These are of two kinds, red and white corpuscles. The red are by far the more numerous, and in man there are about 5,000,000 of them to a cubic millimeter of blood, but this number varies enormously under the influence of parasites. To these red corpuscles is due the red color of the blood, and they are the carriers of oxygen, acquired by the aeration of the blood in the lungs, to the tissues. We breathe in order that they may breathe, for we only care about oxygen in so far as they care about it.

The other kind of corpuscles are the white, or leucocytes, and of these, in health, there are about 7,500 per cubic millimeter. A few years ago it was enough to know that there were red and white corpuscles, but now we have to know more. Through the work of Ehrlich we know that there are at least five different kinds of leucocytes in normal blood, which I will just indicate to you.

1. *Lymphocytes.*—These are the smallest cells, and contain a relatively very large nucleus.

2. *Large Mononuclears.*—These are large, and are called macrophages, as they possess the power of being able to absorb and digest parasites and other foreign bodies.

3. *Polynuclears.*—These are characterized by the irregular, moniliform aspect of their nucleus, and they are called microphages for the same reason that the large mononuclears are called macrophages. Both of these are also called, generally, phagocytes, on account of their power of ingesting and digesting foreign bodies.

4. *Eosinophiles.*—These are characterized by a bilobed nucleus, and by granulations which color deeply with eosin and other acid colors.

5. *Labrocytes or Mastzellen.*—These are rare, and are characterized by large granulations which stain with basic colors.

In parasitic diseases these corpuscles are profoundly modified and altered, numerically and morphologically, and other new elements may make their appearance in the blood.

The blood is essentially the same in all animals, but it varies within certain limits. For instance, the red corpuscles are not of the same size and shape in every animal, and in birds and fishes they are nucleated; in us they are only nucleated in fœtal life and in disease. The mononuclear and polynuclear leucocytes are really separate organisms living in us, and they have qualities which it is very difficult to call anything else but consciousness; so that it is a subtle distinction to draw the line between the parasites—which these leucocytes are, in a way—which are part of us, and those that are not. When the balance of power is well preserved amongst our leucocytes, when they are working well together, then all is well with us; if we are ill, it is because they are quarreling with themselves or with an invader, and

we send for Sir Almroth Wright to pacify or chastize them with his vaccines.

So that, as Darwin said, "An organic being is a microcosm, a little universe, formed of a host of self-propagating organisms, inconceivably minute and numerous as the stars in heaven"—as we ourselves are but parts of life at large.

The three main functions of blood are: that it is a means of respiration, a means of nutrition and a defense against invading organisms.

And now to these latter. A blood parasite proper is a living being, vegetable or animal, passing part or the whole of its existence in the blood of another living being, upon which it lives, this being obligatory and necessary to its life-cycle.

It was in 1841 that the first blood parasite was seen by Valentin in the blood of a fish, and two years later Gruby gave the name *Trypanosoma* to an organism he found in the blood of a frog. But since Laveran's discovery of the malarial parasite in 1880, we have learned to differentiate many other parasites as causal agents of such diseases as I shall mention later in connection with the various parasites. But we know as yet dangerously little about most of them, so that we have strenuously to resist the temptation to make our account of them sound too harmonious, before we have found half the notes of the chord we are trying to play. We speak, as it were, with authorized uncertainty, and there are parts of our science which, after all, are only expressions for our ignorance of our own ignorance. These parasites have a very complicated life-history; part of their life-cycle is passed in the blood of man or beast, and part in various parts of the body of some blood-sucking invertebrate, such as a fly, mosquito or tick, which transfers the parasite to another animal whilst feeding from him. It was thought formerly that blood parasites would be a restricted order, but the work of recent years has shown that they have an enormous distribution both geographically and as regards their hosts. For instance, during the last five years I have had the opportunity of examining all the animals (in the large sense of the word) which have died in the Zoological Gardens. I have examined the blood of over 8,000 animals, coming from all parts of the world, and I have found parasites in the blood of 587 of them, that is, in about 7 per cent., and in 295 species of animals I have found them for the first time. I mention this just to give you some numerical idea of their occurrence and distribution.

It will be better to take first those parasites which live in the plasma, and then those that live in the corpuscles, rather than to attempt to take them in their, at present rather uncertain, biological order; and I will begin at the bottom, biologically speaking, that is, with the bacteria which are plants. These only require mention, since they do not live in the blood as parasites proper, but only as accidental parasites—that is, parasitism is not necessary to their life-cycle; they get into the blood in the later, or in certain, stages of certain diseases.

An example is the blood of a Senegal turtle-dove which died in twenty-six hours from fowl cholera. This bacillus was discovered by Pasteur, and is interesting, as it was his work upon it which led to his discovery of the attenuation of a virus, and of its transformation thereby into a protective vaccine.

The first parasites proper I shall mention are the spirochetes. These have at present rather an insecure position in our idea of nature; they were formerly classed close to the bacteria, but now they are placed tentatively among animals, and

they are not yet quite sure of their place. But they, nevertheless, although insecure of their place in the books, produce grave diseases, such as relapsing fever, tick fever of man, the spirochetoses of horses, oxen and birds, syphilis and yaws. They, with the exception of the last two, are carried by, and developed in, ticks and bugs; and in tick fever the parasite is also found in the nymph form of the tick, and this is one of the rare instances of heredity of a parasite.

The spirochete of relapsing fever in man was discovered by Obermeier in 1868, and he died from inoculating himself with the blood of a patient with the disease. He was one of the first scientific martyrs; he established our knowledge of the cause of this disease at the expense of his own life.

We will now take a long jump to the filariæ. These are nematode worms, the embryo forms of which live in the blood; the parent forms, being too large to get through the capillaries, live in many other parts of the body. The larval form lives in the body of some invertebrate—in a few known cases in a mosquito, or in a crustacean. The microfilariæ were discovered by Demarquay in 1863. Many of them show a remarkable periodicity, some appearing in the blood at an exact hour at night, and some in the day, for which phenomenon there is at present no satisfactory explanation.

Some are short, and some long, and some are encapsuled, others not. Filariæ cause various diseases, probably elephantiasis, and certainly enormous varicosities of the lymphatics, chyluria, chylous dropsy, Calabar swelling and certain tumors.

We now come to the trypanosomes. They are flagellated organisms, which are the cause of many deadly diseases in men and animals; such as sleeping sickness, nagana (or tsetse-fly disease), surra, mal-de-caderas, dourine and others. They are transferred from animal to animal by biting flies, fleas, lice and leeches, in which the sexual part of their life-cycle takes place. The first one was seen in the blood of a frog by Gluge in 1842.

A type example is *T. Lewisi* in the blood of a rat. This was discovered by Lewis in 1878, and is found in about 25 to 29 per cent. of wild rats. Some die, but most recover and become immune; it is a very specific parasite, and can not be transferred to any other kind of animal.

The *T. Brucei*, causing nagana or tsetse-fly disease, probably exists in the wild game of South Africa, much as the *T. Lewisi* does in the wild rats, but when it is carried by the tsetse-fly to domesticated animals it kills them one and all in enormous numbers.

The *T. Gambiense*, which causes sleeping sickness, was first seen by Dutton in 1902, and is carried by another species of tsetse-fly.

Nature attempts to fight against these invaders by phagocytosis. The parasites, however, multiply so rapidly that this method of attack is not very effectual; it can only be so in very early infections, and probably it then often is, that is, before the parasite has had time to start dividing. At the present time the question of trypanosomosis amongst man and animals is, for many countries which have colonies, of the greatest economic importance, so that a great deal of work has been done in the attempt to find a cure. A great many drugs, new and old, have been tried, and some good has been done. The first drug which was found to be of service was arsenic, first in simple and then in complex combination, and the sub-committee of the Royal Society, formed for the purpose of supervising experiments in this direction, suggested the trial of antimony in these

diseases, on account of its near chemical relationship to arsenic.

This has given better results than arsenic, and a commission is at present at work in Africa, in the Lado district, trying its effects on a large scale. We found that the salts of antimony were too rapidly eliminated from the body to be successful in the larger animals and man, and so we devised a very finely divided form of the metal itself which we put directly into the circulation, and this has given, so far, the best results. The leucocytes eat it up and transform it slowly into some soluble form, taking, in a horse, for instance, four days to dispose of one dose, and the effect of this is much more profound and lasting than that of the salts. But some trypanosomes always escape, since one dose is never sufficient for cure. In rats with nagana, in which the trypanosomes by the fifth or sixth day may number 3,000,000 per cubic millimeter of blood, the minimum number of doses for cure has been found to be four, and with this dosage it is possible to cure 100 per cent. of rats. So there is still some hope.

It is interesting in this connection to remember what Bacon, whose death, you know, was due to an experiment he undertook to prove the preservative action of intense cold upon animal bodies, says, "Laying aside, therefore, all fantastic notions concerning them, I fully believe, that if something could be infused in very small portions into the whole substance of blood . . . it would stop not only all putrefaction, but arefaction likewise, and be very effectual in prolonging life." His vision was prophetic!

The bird trypanosomes are very much larger than the mammalian variety, are very dense and move much more slowly.

An example of an organism very closely allied to the trypanosomes which is only found in fishes' blood, and is called a *Trypanoplasma,* has two flagella, and the micro-nucleus is very large. They are probably transferred by leeches, but very little is yet known of them.

There are other flagellated organisms which may appear in the blood and live there as accidental parasites. There is a kind of inflammation of the intestines in reptiles (in the large sense) which causes the mucosa of the intestine to become permeable, so that some of the organisms which live in the intestine are able to get into the blood and live there. The only mention of these organisms in the blood is by Danilewsky, who in 1889 found hexamitus in the blood of a frog and tortoise. When in the blood they appear to excite a general œdema and ascites. I have found them now in nine cases. These are interesting as showing the power of adaptation to new surroundings possessed by these parasites.

I now come to the intracellular parasites. Schaudinn thought that the bird trypanosomes had an intracellular stage, and if this were so they would form a bridge between the extracellular parasites, of which I have shown you types, and the intracellular parasites we are about to consider. But Schaudinn seemed, with his very brilliant attainments, to want a little more ballast of medical earth-knowledge. His work on this point has not been confirmed, and he was probably misled by a double, or even treble infection, so that we must think of these intracellular parasites as quite distinct from the others.

I will take first the *Plasmodium præcox,* the cause of the malaria in birds, as this parasite is of great historical interest; for it was Ross's work on this organism and his discovery of the rest of its life-cycle in the mosquito, which enabled him—on account of the great likeness between this and the parasite causing human malaria—to

deduce from the one the etiology of the other, which was confirmed by Grassi and others. The *Plasmodium præcox* is, in many stages, so like human malaria that it can only be differentiated by the presence of the oval nucleus of the bird's red corpuscles. The life-cycle is very complex, part taking place in the blood of the bird, and another part (sexual reproduction) in the body of a mosquito. This parasite was first seen by Grassi in 1890; it is very widely distributed, and is very deadly to birds.

Human malaria has been known for centuries. Varro, who knew a good deal about what we should now call hygiene, more than a century B.C., thought that malarial fevers were due to invisible animals, which entered the body with the air in breathing, and Vitruvius, Columellus and Paladius were of the same opinion. Now we know that the mosquito is again the carrier, and that the sexual part of the parasite's cycle takes place in it, but whether the mosquito alone can account for all the phenomena of malaria is not yet quite certain.

There are three varieties of malaria in man—the tertian, quartan, and quotidian; in the tertian the cycle of the parasite in the body takes forty-eight hours, and in quartan seventy-two hours, and in pernicious malaria the fever is very irregular, but continuous. Whether there are three different parasites, or only one, which is altered according to its environment of host, climate, etc., is still apparently uncertain. Laveran and Metchnikoff believe in the specific unity of the parasite, whereas some observers want as many as five different species.

Just as in human malaria the pernicious form is distinguished by the elongated form of its gametes, so in birds there is a parasite which is distinguished, in the same way, from *Plasmodium præcox* by its very elongated gametes. This parasite is called *Hæmoproteus Danilewski.* Its development is unknown; it begins as a tiny irregular body in the red corpuscles of the bird, then it grows in the long axis of the cell and turns round the end of the nucleus. It is possible in these parasites to follow the process of impregnation, which normally takes place in some insect. By taking the blood when full of the long, fully-grown gametocytes, and keeping it for a time outside the body, this process can be followed.

First of all, the gametocytes escape from the blood-corpuscles and roll themselves up into a ball. Some of these remain quiet—the females, curiously, the macrogametocytes—whilst in the microgametocytes active movements are seen; then tailed processes are seen projecting from its surface, which at last get free and wander about in the blood, this constituting the origin of the microgametes from the microgametocyte. They then find a macrogamete, and penetrate into it and fertilize it. This fertilized macrogamete then alters its shape and becomes an ookinete, with the remains attached containing the pigment. It may enter a red corpuscle, but it usually breaks up, because it finds it is not in the stomach of the insect it intended to be in, but between two pieces of glass.

From *Hæmoproteus* it is easy to pass to a rare and undetermined parasite of the blood of birds called a *Leucocytozoon.* It occurs in the blood in the form of a long, spindle-shaped, unpigmented body. Very little is known of it except that it is found in its sexual forms. The earliest observers of this parasite—Danilewsky and Ziemann—believed the host-cell to be a leucocyte (hence the name), but Laveran has shown that it is a red corpuscle.

We now come to a group of parasites of great practical importance, the *Babesias,*

formerly called *Piroplasma,* which are the cause of Texas fever or red-water fever, malignant jaundice, East Coast fever, and biliary fever amongst domestic animals. We know, again, little that is certain concerning this group, except that they are unpigmented parasites of the red corpuscles, and are carried by ticks. They are the most destructive to the blood of any we know. In an ox, I have seen the red corpuscles decrease from 8,000,000—the normal—to 56,000 per cubic millimeter in two days.

Another important group, the *Leishmania,* is still uncertain of its exact position. In the body they occur as small bodies with a nucleus and micro-nucleus, but when cultivated on artificial media they become flagellated organisms of a herpetotomas type. It is not quite certain what insect plays the part of carrier, but the different varieties of this group cause the diseases known as Kala Azar or tropical splenomegaly, Oriental sore, Delhi boil, Biskra boil, etc., and also infantile splenic anemia.

The last class are the Hæmogregarines. These are parasites of the red corpuscles of reptiles principally, but they have been described in mammals and birds. We only know certain stages of the greater part of them; they are large, sausage-shaped bodies, not pigmented, and they are supposed to be carried by leeches, ticks, lice and fleas. They generally have a capsule. In some instances the host-cell is enormously enlarged and entirely dehemoglobinized, but in most cases the host-cell is not enlarged.

I have now taken you over some examples of all the known types of blood-parasites, but, at best, the picture in your minds must be like that of a landscape taken from a railway carriage at full speed; and the result, I fear, only a kind of clarified confusion, but it will be something if I have succeeded in making it transparent at the edges. What must have struck you most is the smallness of our exact knowledge of many of these extraordinary organisms and the gaps that there are even in this. But the incitement to future work lies in this fact, for

Things won are done, joy's soul lies in the doing.

HENRY GEORGE PLUMMER

SOME EDUCATIONAL PROBLEMS IN KANSAS[1]

KANSAS partakes of the general educational life of our country and confronts in a large measure the problems presented in all other parts of the United States. Much criticism has been directed against public schools, whether common schools, high schools or colleges and universities. Part of this criticism has been constructive in its aim and founded upon a conscientious loyal purpose. Some of its has been destructive, without adequate basis, and founded upon ignorance or unworthy motives. The conditions that subject the schools to reasonable criticism have been found after investigation to be due not so much to the schools or institutions themselves as to the character of our community life quite beyond the sole control of schools and colleges. This has been true of Kansas and of its institutions of higher education; and the most searching criticism has shown them to be on the whole sound, economical in their management, praiseworthy in their motives and purposes. That there has been waste in education of all degrees there is no doubt, but if we set up the rule that those agencies of life that present waste must be abolished or their fundamental organization and purpose changed, then all the agencies of life must be abolished or their fundamental purpose and organization

[1] Semi-centennial of Kansas State Agricultural College, October 29, 1913.

changed for there is no perfection in any human agency and all are subject to the charge of waste. I believe that the charge of waste, so far as money waste is concerned, has less foundation in connection with education than in connection with most other agencies of our American life. This I believe to be true of Kansas also. Waste in education does not necessarily arise through a large expenditure of money. It arises much more from the lack of large expenditures of money, for all those who are acquainted with the great problems of education will probably agree that there is no waste so great, no extravagance so unjustifiable as a false economy in education and there is no use of funds so truly economical, so immensely efficient as an expenditure of public funds upon education as large as the demands of our time and the outlook for the future makes necessary. Therefore, as I view it, the problem with us is not the reduction in the expenditures by the state for education but a large increase in the expenditures of the state, and a most careful and efficient administration of those expenditures on the basis of the most expert and experienced advice that our most expert and experienced administrators can give.

2. That there has been a change in the general purpose of education there can be little doubt. This was inevitable in connection with the movement toward the democratization of American life. It is another aspect of the movement, whether we like it or not, to achieve a real democracy in the United States. To accomplish this without the aid of the schools would be most difficult for the schools are the main agency by which the achievements of the past are handed down to succeeding generations and by which fundamental changes in the general operations of our life must be maintained. If the purpose of education remained the same, if the intellectual discipline of our schools remained absolutely rigid, progress would be almost if not quite impossible. Every decade brings its new discoveries. All of these accretions must be added to what we are to hand down to the rising generation. The modern public high school, the modern public university, bringing as they do within their sphere of influence a vast throng of boys and girls from every walk of life had to be adjusted to the needs of this heterogeneous mass and the institutions that were originally planned for the development of a profession or for a few callings in life or for the more fortunate classes in our country have been obliged to adapt themselves to the new aspect of our national life. No change so great as this may ever go on without its accompanying dangers. This change has been so rapid and so revolutionary as to make permanent adjustment difficult. The danger here lies in the possibility that the basis of education may become the purpose solely or largely to train for the ability to accumulate wealth. In other words it may become materialistic. Whatever defects the old training had it was free from materialism. Therefore, as I view it, the problem in Kansas is by far-sighted wisdom to secure such permanent adjustment as shall make our institutions of learning hospitable to all the permanent shiftings of our community life and at the same time to avoid a materialistic purpose and basis of education.

3. Vocational education has been a necessary outcome of the general industrial development in our American life, and of the change in the purpose of our education. In 1889–90 there were only 203,000 pupils in the public high schools in America. There were in 1911–12, 1,105,000. In 1889–1890 there were in colleges, universities

and schools of technology, 66,000. In 1912 there were 198,000. That this great multitude of boys and girls crowding into our colleges and universities should not be shunted off from the trades and industries, from a contact with and a knowledge of hand labor, that they should be able to earn a competent living, vocational training was inevitable. In this connection there are at least two things that ought by all means to be considered. In the first place any arrangement of American education that shall lead to stratification of our population by which one class is turned perforce in one direction and another in another would be a national calamity. No such stratification as has occurred in Germany could be tolerated in America. No teacher or administrator must ever have the authority to say to one boy that he may go on into the high school and prepare for college and issue with all that the college or university can give him, and to another boy that he must go into a trade school and issue as a hand laborer. There must be absolute freedom for the choice of the individual and the road must be open from the kindergarten to the university for every boy or girl that has any aspirations for the highest training. Then again, if we are to have vocational training and if we are to deal with this great multitude in an adequate fashion, vocational guidance must go with vocational training. There must be adequate supervision, adequate suggestion and guidance by which boys and girls may be made acquainted with the different trades, industries and professions; given some adequate insight into the purposes and requirements of each so that they may have not coercion but assistance in arriving at the task in life that each desires to perform. I hope to see in the university over which I preside the development of competent agencies for investigation into the individual aptitude of students and the introduction of courses and other means for vocational guidance and information concerning trades, industries, professions and business callings.

4. There is no aspect of our education whether in the United States or in our own state that is more disheartening or that raises more questions of doubt than the adequate supply and the adequate quality of teachers for our schools of every grade. To overcome this, undoubtedly two things are absolutely necessary. First, the independence of the teacher, permanency of tenure, the respect that is due to a great and dignified calling. No class of men or women of any spirit or ability will enter a profession, or having entered long remain in it, if their independence, their right of initiative and free speech as American citizens is in any way in question. Nor will they enter a profession or long remain in it if their tenure of office is lacking in permanency or subject to any uncertainty arising from the exigencies of politics or too frequent changes in administrative policy. Unless these evils are remedied I fear, from many evidences during the last few years, that we must look for a decrease rather than an increase in the number and quality of our teachers.

But perhaps the most vital consideration in this respect is the condition of teachers' salaries. I refer here to the salaries in all grades of schools, including colleges and universities. The salaries in our colleges and universities are, so far as relation to purchasing power and living conditions is concerned, lower I believe than they have ever been in the history of the institutions. The report of the commissioner of education for 1912, page 29, has a section dealing with this point. It gives a summary of the report of a committee of the National Education Association on

teachers' salaries and the high cost of living. Taking it as the basis of authority we may note that

> The United States Bureau of Labor found that in 1911 wholesale prices were 44.1 per cent. higher than in 1897. Measured by wholesale prices a teacher whose salary had remained fixed at $1,000 since 1897 would have no greater purchasing power in 1911 than $693 possessed in the earlier year.
>
> The increase of wholesale prices has, of course, been reflected to a greater or less degree in retail prices generally. . . . In June, 1912, retail food prices were 61.7 per cent. higher than the average for 1896.

In any college or university, therefore, where the salaries of professors have remained at from $2,000 to $2,500 the teacher has found a tremendous decrease in the actual value of what he received. The result has been, as the Carnegie Foundation reports so ably show, a drawing off from the teaching profession on the part of many able men and women who for the good of our education ought to have remained. A further continuance of this condition will draw off a still greater number and make it more and more difficult to persuade men especially to enter the teaching profession.

5. One of the great problems confronting education in Kansas as elsewhere is still the moral and religious problem. If any were misled years ago into the belief that intellectual training provided sufficient safeguards and moral standards, certainly our experience in the last decade must have disillusioned him. There is nothing so futile as the attempt to make intellectual training take the place of moral and religious training and no man is so dangerous as the educated man gone wrong. In my judgment the grave point of danger in our schools is not the college or university. Long experience leads to this conclusion and statistics and general observation point inevitably to the same conclusion. The grave point of danger is the home and high school and here must the great work be done, for after all ours with all its defects is a Christian civilization. Historical Christianity is the basis of our whole life and we, as a nation, shall stand or fall with it.

6. One of the problems confronting all states having several institutions of higher education is their proper correlation. The demand for such correlation in Kansas has come about to some extent from the belief that large duplication exists which might easily be eliminated by an arbitrary decree fixing the field of each institution. It has been thought by some that it would be feasible to define precise and narrow limits for the institutions and to confine them strictly within such limits. As soon as one considers this problem carefully with a full understanding of practical conditions it becomes evident that such a narrow delimitation is impossible and if it should be undertaken upon any precise theory it might result in disastrous dismemberment of our institutions and great harm to our education. No one, so far as I know, would undertake to defend duplication which is artificial and gratuitous, which has no substantial basis and is not a necessary concomitant of the genius of the institution itself. But every institution must round out its life and do what necessarily arises in its field of operation.

The demand for correlation has arisen in the second place from a belief that large duplication exists, necessarily giving rise to an unusual and useless cost of education. The total cost of higher education in Kansas is large and at this point it is commonly assumed that the cost per institution and per student must be excessive and that duplication must be the cause of it. This belief is unwarranted. Now, there

is one infallible test of whether or not education in our Agricultural College or University is costing too much and that is a comparison of our per capita cost with that of other like institutions in other states, for taking a long series of years together there is no standard of the necessary cost of education so accurate as the average cost in institutions of practically the same grade. Indeed it would be impossible for any considerable duplication of effort to exist in Kansas without largely increasing the cost per student. To show that the cost per institution and per student in Kansas is not large one has only to compare the average cost of other institutions and their cost per student with our own. Such a comparison will show in practically every case that without question the cost of education in the Kansas Agricultural College and the University of Kansas, both as to the institutions themselves and as to their cost per capita, is below the average of other institutions of like rank. The large cost of education in Kansas arises rather from the unprecedented number of young people that Kansas undertakes to educate. There were students, residents of Kansas, in the University and Agricultural College in 1911–12, to the number of 4,594. If Iowa had educated as many according to population as Kansas, instead of 4,163 resident students in its University and Agricultural College it would have had 6,317; Wisconsin, instead of having 3,945 would have had 6,341; Indiana, instead of 3,889 would have had 7,339; Michigan instead of 4,509 would have had 7,636; Missouri instead of 2,740 would have had 8,949, and Illinois instead of 3,504 would have had 15,322. The question that arises, therefore, is not excessive cost per student but shall Kansas continue to educate its young people in unusual and ever increasing numbers and pay the necessary cost? I believe that most of us would answer most emphatically in the affirmative.

The question of coordination of institutions suggests another danger that might arise through an attempt to standardize institutions within a given state and make them uniform in their purpose, their spirit and their outlook. I believe that nothing worse could happen in Kansas education. The value of our institutions lies largely in their being different, in having different problems to solve, in having a different life, a different point of view. A college or a university has a soul as has a man and the personality of an institution and the integrity of its life at all hazards must be maintained. It must be held to its primary purpose and acquit itself valiantly in its own domain. It seems to me, therefore, that the watchword in Kansas must be cooperation; that the teaching bodies of each institution must have and exercise powers of initiative and internal control in order to visualize and develop their own problems and maintain their own integrity and independence; that at the same time they must cooperate most fully with the board of administration and every other proper agency of education in their every endeavor to secure a true and fundamental cooperation to the end that our education, while as diverse as the different agencies connected with it, shall after all have a true and noble unity.

Frank Strong,
Chancellor
University of Kansas

THE AMERICAN SOCIETY OF NATURALISTS

The American Society of Naturalists in affiliation with the American Society of Zoologists, the American Association of Anatomists, and the Federation of American Societies for Experimental Biology, will hold its thirty-first

meeting at Philadelphia, under the auspices of the University of Pennsylvania, on Wednesday, December 31, 1913.

The morning session will be open for papers on evolution, genetics and related subjects from members or invited guests, titles of which with estimated length of delivery must be in the hands of the secretary by December 1. Requests for microscopes or for space for demonstrations should also be sent to the secretary.

The program of the afternoon will be a symposium on "The Scope of Biological Teaching in relation to New Fields of Discovery." The annual dinner will be held in the evening of the same day.

Headquarters of the affiliated societies will be at the Hotel Walton, Broad and Locust Streets.

BRADLEY M. DAVIS,
Secretary

UNIVERSITY OF PENNSYLVANIA

THE AMERICAN PSYCHOLOGICAL ASSOCIATION

MONDAY, Tuesday and Wednesday, December 29, 30 and 31, have been selected as the dates for the twenty-second annual meeting of the American Psychological Association. At the invitation of the psychologists at Yale University, the sessions will be held in New Haven, in affiliation with the American Philosophical Association.

One joint session of the two societies will be arranged. At the present time it is still uncertain whether this session will be devoted wholly to discussion of the theme, "The Standpoint of Psychology," or whether a varied program will be made by selecting from among the papers offered, a few of those that promise to be of greatest interest to the membership of both associations.

Round Tables.—It has been proposed to provide time on the program for informal round-table conferences of small groups of psychologists who are particularly interested in some more or less specialized subject. "Psychological Tests of College Freshmen," for example, is one of the topics in which several laboratories seem to have a waxing interest just now, and doubtless an informal interchange of ideas and experience would have some value. More or less related themes are "Psychological Tests and Vocational Guidance"; "Graded Measurements of Adult Intelligence"; "Problems of Psychological Research among Defectives and Delinquents." A timely topic, sure to call out a clash of ideas, has been suggested to the secretary from different quarters, "The Movement toward Divorce of Philosophy and Psychology." Is psychology, more than any of the other natural sciences, dependent on philosophy? In how far are the two disciplines being benefited by the rapidly spreading tendency toward separation of the two departments in university organization?

This year, as usual, the main portion of the program will be reserved for reports of experimental research. The experience of recent meetings has convinced the committee that these reports are of the greatest value when they do not undertake to go into detail, but aim instead to state clearly, but briefly, the nature of the problem and the method of attack, and then pass at once to the general summary of the results and a discussion of the conclusions reached, leaving the mass of detailed results to be presented when the research is published in full. It is impossible to compact an effective report of research into the ten or fifteen minutes allowed, when an effort is made to include in it a bulk of detailed information which is beyond the maximal span of the attention of an average psychologist.

Cards for use in sending in the titles of reports will be mailed to all members shortly.

The Yale laboratory affords excellent quarters for the display of apparatus. Members are asked to inform the secretary of any new form of apparatus or any useful demonstration device which has not already been brought to the notice of this society. Improvements on standard appliances are often quite as worthy of attention as entirely new forms. The expense of transportation will, up to a certain limit, be assumed by the Association.

The secretary wishes this year to gather together a varied assortment of printed and mimeographed syllabi, outlines, laboratory directions, charts, blanks, bibliographies of supplementary and suggested readings, review questions, examination questions and the like, so that we may all see something of the minor aids to instruction which our colleagues are employing. He begs that each one who reads this announcement will take the few moments of time necessary to mail to him at once a packet containing samples of all material of this sort which happens to be accessible.

W. V. Bingham,
Secretary

Dartmouth College

THE DANA CENTENARY

In commemoration of the great geologic work of James Dwight Dana, Yale University will hold a centenary celebration next December, to consist of a series of lectures, culminating in a Dana Memorial volume on "Problems of American Geology." The lectures will be given on the Silliman Foundation, and are open to all interested persons. The speakers and their respective subjects are as follows:

PROBLEMS OF AMERICAN GEOLOGY

Introduction

"The Geology of James Dwight Dana," Professor William North Rice, of Wesleyan University, Tuesday, December 2, 8 P.M.

I. *Problems of the Canadian Shield*

"The Archeozoic and its Problems," Professor Frank Dawson Adams, of McGill University, Thursday and Friday, December 4 and 5, 5 P.M.

"The Proterozoic and its Problems," Professor Arthur Philemon Coleman, of the University of Toronto, Wednesday and Thursday, December 10 and 11, 5 P.M.

II. *Problems of the Cordilleras*

"The Cambrian and its Problems," Dr. Charles Doolittle Walcott, of the Smithsonian Institution, Monday, December 15, 5 P.M.

"The Igneous Geology and its Problems," Professor Waldemar Lindgren, of the Massachusetts Institute of Technology, Tuesday, December 16, 5 P.M.

"The Tertiary Structural Evolution and its Problems," Dr. Frederick Leslie Ransome, of the United States Geological Survey, Wednesday, December 17, 5 P.M.

"The Tertiary Sedimentary Record and its Problems," Dr. William Diller Matthew, of the American Museum of Natural History, Thursday and Friday, December 18 and 19, 5 P.M.

SCIENTIFIC NOTES AND NEWS

It is announced that M. Charles Richet, professor of physiology in the University of Paris, has been awarded the Nobel prize for medicine.

The Royal Society of Edinburgh has elected honorary fellows as follows: Professor Horace Lamb, F.R.S., professor of mathematics in the University of Manchester; Sir W. T. Thiselton-Dyer, K.C.M.G., F.R.S., formerly director of the Royal Botanic Gardens, Kew; Dr. G. E. Hale, director of the Mount Wilson Solar Observatory (Carnegie Institution of Washington); Professor Emil C. Jungfleisch, professor of organic chemistry in the College of France, Paris; Professor S. Raymón y Cajal, professor of histology and pathological anatomy in the University of Madrid; Professor V. Volterra, professor of mathematics and physics in the University of Rome; Professor C. R. Zeiller, professor of plant paleontology in the National Superior School of Mines, Paris.

Professor W. M. Davis, of Harvard University, has been granted an appropriation from the Shaler Memorial Fund to defray in part the expense of his trip to the South Pacific to study the physiographic evidence relating to the problem of coral reefs.

At its last meeting held on November 12, 1913, the Rumford committee of the American Academy appropriated the sum of $250 to Professor Louis V. King, of McGill University, to defray the expenses of computation for his research on "The Scattering and Absorption of Solar Radiation in the Earth's Atmosphere."

The council of the Royal Meteorological Society has awarded the Symons Gold Medal to Mr. W. H. Dines, F.R.S., in recognition of

the valuable work which he has done in connection with meteorological science. The medal will be presented at the annual meeting of the society on January 21, 1914.

Professor Julius Stieglitz, of the department of chemistry in the University of Chicago, is a member of the committee appointed by the Chicago section of the American Chemical Society to cooperate, if desired, with the mayor of Chicago in the solution of the city's waste problem. Other members of the committee are Professor John H. Long, of Northwestern University, and Professor Harry McCormack, of the department of chemical engineering in the Armour Institute of Technology.

Professor E. E. Southard, of Harvard University, has been made a member of the board of scientific directors of the Eugenics Record Office, Cold Spring Harbor, N. Y. Professor Southard has also been made a member of the consulting board for the laboratory erected by the Bureau of Social Hygiene in connection with the State Reformatory for Women at Bedford Hills, N. Y.

We learn from *The Observatory* that owing to the continued illness of Professor Sir Robert Ball, Professor Newall has been made deputy director of the Cambridge Observatory.

Mr. H. Knox Shaw has been appointed superintendent of the Helwân Observatory, Egypt.

Edgar T. Wherry, Ph.D. (Pennsylvania, '09), lately assistant professor of mineralogy at Lehigh University, has been appointed assistant curator of mineralogy and petrology in the department of geology, United States National Museum, succeeding Mr. Joseph E. Pogue, transferred to the United States Geological Survey, and James C. Martin, Ph.D. (Princeton, '13), has been appointed assistant curator of physical and chemical geology, succeeding Mr. Chester G. Gilbert, now curator of mineral technology.

Mr. Thomas Lancaster Wren, who took a first class in the mathematical tripos in 1909 and 1911, and Mr. Franklin Kidd, son of Benjamin Kidd, the author of "Social Evolution," who took a first class in the natural science tripos in 1912, have been elected to fellowships in St. John's College, Cambridge.

Dr. S. Chapman, chief assistant at the Royal Observatory, Greenwich, has been elected a fellow of Trinity College, Cambridge.

The clinical congress of surgeons of North America was held in Chicago last week. In addition to the clinical demonstrations held in the various hospitals of the city, eight evening sessions were devoted to the reading and discussion of papers. Among those who made addresses before the congress were Dr. Edward Martin, Philadelphia; the retiring president, Dr. George E. Brewer, of New York; the incoming president, Sir W. Arbuthnot Lane, London; Dr. Carl Beck, Chicago; Dr. John B. Deaver, Philadelphia; Dr. Howard Kelly, Baltimore; Dr. C. J. Gauss, Freiburg; Dr. Roswell Park, Buffalo; Dr. James Ewing, New York, and Dr. Charles Mayo, Rochester.

Professor H. Monmouth Smith, of Syracuse University, who has for several years been a volunteer investigator in the nutrition laboratory of the Carnegie Institution of Washington, Boston, has recently accepted a position on the laboratory staff in connection with the respiration calorimeters.

Dr. Alois Riehl, professor of philosophy at the University of Berlin, and formerly rector of the university, will give two lectures, in German, in Emerson Hall, Harvard University, on the afternoons of November 17 and 18. The topics are "Nietzsche" and "Nietzsche and Bergson."

At the regular monthly meeting of the Cosmos Club on November 10, Dr. Bailey Willis gave an address on "Present Day Conditions in Argentina."

The eighty-eighth Christmas course of juvenile lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Professor H. H. Turner, F.R.S., Savilian professor of astronomy in the University of Oxford, his title being, "A Voyage in Space." The lectures will be experimentally illustrated, and the subjects are as follows: The Starting Point—Our Earth, The Start

through the Air, Journeying by Telescope, Visit to the Moon and Planets, Our Sun, The Stars.

Arthur J. Frith, professor of engineering in the Armour Institute, Chicago, died on November 10.

The death is announced of Dr. Arthur Edgar, instructor in chemistry at Columbia University.

Dr. Edwin Klebs, the well-known pathologist and bacteriologist, died at Dortmund, on October 21, aged seventy-nine years.

Sir John Batty Tuke, M.D., member of parliament for the universities of Edinburgh and St. Andrews, and Morison lecturer on insanity and mental diseases in the Royal College of Physicians of Edinburgh, died on October 31, aged seventy-eight years.

Dr. Adolf Hoffman, professor of geology in the mining school at Przibram, has died at the age of sixty years.

Dr. Simon von Nathusius, professor of agriculture at Halle, has died at the age of forty-eight years.

The death is also announced of Dr. Ferdinand Blumentritt, of Leitmeritz, in Bohemia, known for his scientific work in the Philippine Islands.

The U. S. Civil Service Commission announces an examination for assistant in agricultural technology, for men only, on December 3, 1913, to fill vacancies in this position in the Bureau of Plant Industry, Department of Agriculture, Washington, D. C. The eligibles obtained from this examination will be classified in two groups, with salaries ranging as follows: Group A, \$1,600 to \$2,250 per annum; group B, \$1,200 to \$1,440 per annum. The services of the eligibles to be selected from Group A are desired in the laboratory of agricultural technology in the preparation of the official cotton grades, their work requiring an intimate knowledge of cotton grading and the various processes of cotton manufacture.

M. Durandeau, of Angoulême, has bequeathed £2,000 to the Pasteur Institute, Paris, for the foundation of a prize for researches on the cure of meningitis.

The International Congress of Hydrology just held at Madrid decided that the next meeting should take place two years hence at Lyons.

At the twenty-third annual meeting of the Ohio Academy of Science, which will take place at Oberlin College on November 27, 28 and 29, in addition to the reading of papers, an address will be given by Professor L. B. Walton, the president of the academy, on "The Evolutionary Control of Organisms and Its Significance" and an illustrated lecture on "Sound," by Professor Dayton C. Miller, of the Case School of Applied Science.

A regular meeting of the American Physical Society will be held in Chicago on Friday and Saturday, November 28 and 29. On Friday afternoon there will be a special session to discuss "The Photoelectric Effect and Quantum Theory."

A memorial meeting to the late Reginald Heber Fitz, Hersey professor of the theory and practise of physic, emeritus, was held in the Harvard Medical School, November 17. Addresses were made by Dr. W. W. Keen, of the Jefferson Medical College; President Charles W. Eliot; Dr. Henry P. Walcott, chairman of the Board of Health of the State of Massachusetts; Dr. William Sydney Thayer, of Johns Hopkins University, and Dr. William T. Councilman, of the Medical School.

The faculty and the graduate students of the department of botany in the University of Illinois have recently organized a society known as "Silphium." The purpose of the organization is the presentation of original articles by the members, the review of recent literature, and also to obtain a better acquaintance with the flora of the immediate region. Dr. T. J. Burrill, professor emeritus of botany, has been chosen its honorary chairman.

The Physical Science Club of Oberlin College has organized for the year with Dr. Moore, associate professor of physics, as president, and Professor Hubbard, head of the department of geology, as secretary and treasurer. The opening meeting was addressed by Dr. Stetson, head of the department of psy-

chology, who spoke on "The Introduction to Science." The Physical Science Club is composed of members of the teaching staff, graduate students and qualified undergraduates in the physical sciences. The members meet each week for the presentation of research work, special papers and general discussion.

AT the completion of its fiftieth volume, *The American Chemical Journal,* founded and edited by Dr. Ira Remsen, will be discontinued as a separate publication and will be incorporated, from January, 1914, with the *Journal of the American Chemical Society.*

PURSUANT to arrangements made at the Eighteenth International Congress of Americanists, in London, 1912, the Nineteenth Congress will meet in America in 1914 in two sessions, the first at Washington, from October 5 to 10, and the second at La Paz, Bolivia. The session at Washington will be held under the auspices of the Smithsonian Institution, in cooperation with the George Washington University, Georgetown University, the Catholic University of America, the Anthropological Society of Washington, and the Washington Society of the Archeological Institute of America. During the session an excursion will be made to the highly interesting aboriginal quarry and workshop at Piney Branch, District of Columbia; and following the congress it is expected that two excursions will be arranged, one to Ohio for the examination of ancient mounds, the other to New Mexico for the study of ancient ruined pueblos and cliff-dwellings, as well as of the present Pueblo Indians in their native environment. The officers of the organizing committee are: *President*—William H. Holmes; *Secretary*—Ales Hrdlicka; *Treasurer*—Clarence F. Norment.

WORD has been received in Cambridge that the collection of Egyptian objects made by Professor Reisner for the Harvard University Museum has been partially destroyed on the way to America. The ship which was bringing it caught fire and was forced to return to a German port. The extent of the damage has not yet been determined. The collection consisted of prehistoric skeletons, pottery, flints and a series of Egyptian anatomical remains.

WE learn from the *Electrical World* that at a meeting in Brussels on October 13 a "Commission Internationale Scientifique de Télégraphie sans Fil" was established for the scientific study of radio-telegraphic waves and their phenomena. The president is Mr. W. Duddell, of London; the secretary, M. Robert Goldschmidt, of Brussels; the vice-president, Professor W. Wien, of Jena. On and after January 1, 1914, at least until March 1, 1914, certain test messages will be sent from a station in Brussels at hourly intervals, on a wavelength of 3,300 in. Check measurements of the wave frequency, group frequency, power and other details will be made and recorded at Brussels. Observers are invited to measure these signals, as often, and at as many different places, as possible. It is hoped that national committees may be regularly appointed to cooperate in the movement, the objects of which are to increase the knowledge of electric radiation and meteorology. The distance from Brussels to New York is in the neighborhood of 4,000 statute miles, and to Chicago about 5,000; so that the signals which one can hope to receive in this country from Brussels are likely to be very weak. However, if the limiting distance at which these signals can be detected is determined in America, that fact will have significance and utility.

THE *Journal* of the American Medical Association states that an attempt is being made to establish, at the Army Medical Museum, Washington, D. C., an extensive library and lantern and stereoscopic slides of radiographs, representing the work of radiographers who have done particularly notable work along certain lines. Enough slides have already been received to make the collection of value for reference and for teaching purposes at the Army Medical School. Those who have already contributed to the collections are Dr. Lewis Gregory Cole, New York City, slides of stomach, lung and kidneys; Dr. William H. Dieffenbach, New York City, slides of diseases of bones; Dr. Kennon Dunham, Cincinnati, Ohio, stereoscopic slides of the lungs; Dr. Walter C. Hill, Cleveland, Ohio, slides of dis-

eases of bone, and Dr. James T. Case, Battle Creek, Mich., slides of the alimentary tract. Others have promised to send slides, and it is the intention to add to the collection from time to time as important work is done. The collection is available for study by any civilian practitioner on application to the curator, Army Medical Museum, Washington, D. C.

WE learn from the *Journal* of the American Medical Association that acting under auspices of the commission appointed by the Medical Society of the State of Pennsylvania for the Conservation of Vision that an active campaign is under way against ophthalmia neonatorum, needless eye injuries in the trades, trachoma, wood alcohol, wrong lighting of buildings and like causes of blindness. In addition to a large number of distinguished laymen, acting as advisory members, the Commission on Conservation of Vision includes Dr. Wm. Campbell Posey, Wills Eye Hospital, Philadelphia, chairman; Dr. Wm. W. Blair, University of Pittsburgh, Pittsburgh, Pa.; Dr. Clarence P. Franklin, Philadelphia; Dr. C. M. Harris, Johnstown, Pa.; Dr. Edw. B. Heckel, Pittsburgh, Pa.; Dr. T. B. Holloway, University Hospital, Philadelphia, secretary; Dr. Wendell Reber, Temple University, Philadelphia; Dr. Edward Stieren, Pittsburgh, Pa.; Dr. Lewis H. Taylor, president of State Society, Wilkes-Barre, Pa.; Dr. Wm. Zentmayer, Wills Eye Hospital, Philadelphia; Dr. Samuel G. Dixon, commissioner of health of the state of Pennsylvania, Harrisburg, Pa., honorary chairman.

ALASKA coal fields continue to be undeveloped, according to the United States Geological Survey. The only coal being mined is some lignite coal taken out for local use at Cook Inlet, on Seward Peninsula, and at several other localities. The total production in 1912 did not exceed 100 or 200 tons. One oil company continued operations in the Katalla petroleum field in 1912, as in 1911. One of the two producing wells is said to have been sunk to a depth of about 800 feet. The oil is procured by pumping and is refined in a small plant located near Katalla, and the gasoline finds a ready sale in the coastal settlements of this part of Alaska. There are several other oil companies which control property in this field, but these seem to have done little in the way of development during 1912.

UNIVERSITY AND EDUCATIONAL NEWS

A GIFT of $4,350,000 to the Cornell Medical School is now officially announced. The name of the donor is withheld but he is believed to be Col. Oliver H. Payne, of New York City.

AT the conference of the Association of American Universities, held November 6, at the University of Illinois, eighteen of the twenty-two institutions admitted to membership were represented as follows: University of California, Dean A. O. Leuschner; Catholic University of America, Professor D. W. Shea; University of Chicago, Dean Rollin D. Salisbury and Dean Albion W. Small; Clark University, Professor J. W. Baird; Cornell University, Dean E. Merritt; University of Illinois, Dean D. Kinley and Dean K. C. Babcock; State University of Iowa, Dean C. E. Seashore; Leland Stanford Junior University, Professor W. W. Willoughby; University of Kansas, Professor F. H. Hodder; University of Michigan, Dean K. Guthe; University of Minnesota, Dean G. S. Ford; University of Missouri, Dean I. Loeb; University of Nebraska, Dean L. A. Sherman; University of Pennsylvania, Dean H. V. Ames and Dean J. C. Rolfe; University of Wisconsin, Director G. C. Comstock.

THE non-resident lectures in the graduate course in Highway Engineering at Columbia University appointed for the 1913–1914 session are as follows: John A. Bensel, New York State Engineer; William H. Connell, chief, Bureau of Highways and Street Cleaning, Philadelphia; C. A. Crane, secretary, the General Contractors Association; W. W. Crosby, chief engineer, Maryland Geological and Economic Survey, and consulting engineer; Charles Henry Davis, president, National

Highways Association; John H. Delaney, commissioner, New York State Department of Efficiency and Economy; A. W. Dow, chemical and consulting paving engineer; H. W. Durham, chief engineer of highways, Borough of Manhattan, New York City; C. N. Forrest, chief chemist, New York Testing Laboratory; Walter H. Fulweiler, chief chemist, United Gas Improvement Company; Frank B. Gilbreth, consulting engineer; George P. Hemstreet, superintendent, The Hastings Pavement Company; Samuel Hill, president, American Road Builders' Association; D. L. Hough, president, the United Engineering and Contracting Company; J. W. Howard, consulting engineer; Arthur N. Johnson, state highway engineer of Illinois; William H. Kershaw, manager, Paving and Roads Division, the Texas Company; Nelson P. Lewis, chief engineer, Board of Estimate and Apportionment, New York City; Harold Parker, first vice-president, Hassam Paving Company; Paul D. Sargent, chief engineer, Maine State Highway Commission; Philip P. Sharples, chief chemist, Barrett Manufacturing Company; Francis P. Smith, chemical and consulting paving engineer; Albert Sommer, consulting chemist; George W. Tillson, consulting engineer to the president of the Borough of Brooklyn.

DR. O. W. RICHARDSON, F.R.S., professor of physics in Princeton University, has been appointed to the Wheatstone chair of physics at King's College, London, in succession to Professor C. G. Barkla, F.R.S.

DR. KARL BOEHM, of Heidelberg, has been appointed professor of mathematics in the University of Königsberg as successor to Professor G. Faber.

DISCUSSION AND CORRESPONDENCE

ATOMIC IONIZATION AND ATOMIC CHARGES

IN a discussion of "The Rutherford Atom" in SCIENCE for August 22 Mr. Fulcher gives Kleeman's table of the relative ionization of different elements by the β and γ radiation and concludes that "atomic ionization seems to depend primarily upon the atomic weight, which is probably proportional to the number of electrons in the atom."

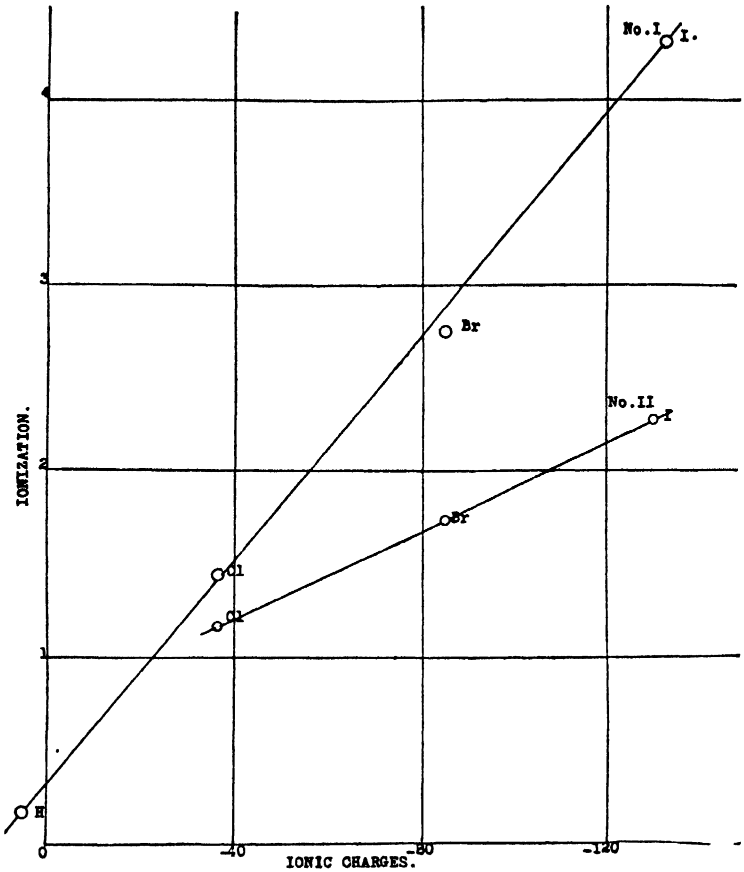
Whatever theory of atomic structure we may adopt, it seems certain that electrons are held to their atoms by electrical forces in which the mass of the atom can play no part. If a relation exists between the mass of an atom and its electrical charge, then a corresponding relation should exist between its mass and its attraction for electrons. Since the ionization investigated by Kleeman consisted in the separation of electrons from their atoms by the discharge of α, β and γ radiation through the substance, it seems probable that the weaker the hold of the atoms upon their electrons the greater would be their ionization.

Elsewhere I have tried to show that it is possible to calculate the electrical charges of a number of free atoms from their atomic mass and their velocity in electrolysis. If the above reasoning is correct, the charges calculated in this way should bear a definite relation to the ionization in Kleeman's investigation.

Unfortunately, the atomic charges can be calculated in this way for only four of the elements in Kleeman's table, but the indications given by these four seem so conclusive that I have thought it worth while to present them here. The four elements referred to are hydrogen, chlorine, bromine and iodine. Their relative ionization by the different rays and their charges as electrolytic ions are given in the table below.

Element	Ionization			Charge
	α Rays	β Rays	γ Rays	
H..................	.175	.18	.18	+ 5
Cl..................	1.16	1.44	1.44	− 36.5
Br..................	1.72	2.76	2.81	− 84.9
I..................	2.26	4.10	4.50	−132.5

It will be seen that while the ionization produced by the β and γ rays is practically the same, that produced by the α rays is much less. In either case, however, there is a constant relation between the ionic charges and the amount of ionization, showing that the greater the negative charge of the atom the



greater the ionization. This relation is shown graphically in the following curves, where No. I. shows the mean ionization produced by the β and γ rays as compared with the ionic charges and No. II. shows the same relation for the a radiation.

FERNANDO SANFORD

STANFORD UNIVERSITY,
September 30, 1913

SCIENTIFIC BOOKS

THE MARYLAND DEVONIAN BOOKS

THE fine series of volumes issued by the Maryland Geological Survey (Professor Wm. Bullock Clark, state geologist) has recently been substantially supplemented in number and enhanced in worth by the publication of what may, for brevity, be styled the "Maryland Devonian Books."[1]

Following the tasteful pattern and admirable mechanical execution of the previous members of the series, the Devonian books constitute a graceful and enduring monument to the scientific vigor of the State of Maryland in which His Excellency, The Honorable Phillips Lee Goldsborough, and his distinguished colleagues of the Geological Survey Commission may take a just and satisfying pride. These books are three stout volumes and the golden device of the state which they carry on their covers declares that good men have done this work at the command of the presiding genius of Maryland. The accomplishment of this undertaking is the fulfilment

[1] Maryland Geological Survey: Lower Devonian. Text, 560 p.; Middle and Upper Devonian. Text, 719 p.; Plates (Lower Devonian, 1–98; Middle Devonian, 7–44; Upper Devonian, 45–73). Baltimore, The Johns Hopkins Press, 1913.

of a long promise and there need be no reserve in saying that the result is destined to be of great value and durable service to geological science.

Amid the diversified output of official reports on American geology there has been nothing like this before—a monograph of a single geological system and its component faunas, wherein is given in detail all that is known of the local development of the system within definite, if artificial, boundaries. The very expression of this fact, the realization that here is a work of ultimate reference in this field, brings with it the wish that other states might have done like this for their own domain and to the great advantage of those who seek to interpret the causes and sequences of geology along the broader lines. Many expert men have participated in the creation of this work; and here again, as so often, our venerable adages break down, for many cooks have neither spoiled the broth nor have many hands made light work; for first, the collaborators speak with reasonable finality, and again, the conception of the state geologist has labored long and hard, through many years, to this successful parturition.

The writer, having played a certain rôle in the rendering of this composition, must refrain from any exuberant notice of it. Nor would a critical review of the contents of the work be appropriate to these columns. All in due time the geological coroner with his hypotheses will be along to hold his inquest over the *corpus delicti*.

Volume 1 is devoted to the Lower Devonian, volume 2 to the Middle and Upper Devonian, and volume 3 consists of 165 plates, including 2,500–3,000 figures of fossils. The text volumes are embellished with many half-tones of geological scenery and accompanied by section sheets in cover pockets, and volume 1 carries a map of Maryland with the Appalachian distribution of the Devonian members accurately colored.

The introductory chapter on the general relations of the Devonian by Dr. Swartz points out succinctly the correlation of the formation in its various aspects, laying special emphasis on the discrimination of shore-line and subcontinental deposits at the east from contemporaneous marine deposits toward the west, in correspondence with later Devonian conditions northward in Appalachia. Professor Schuchert has presented the paleogeography of the Devonian with the aid of a series of paleogeographic maps of North America, which illuminate the procession of geographical changes and are serviceable for dogmatic purposes, even though recent blows of the hammer have torn some cavernous rents in them.

Dr. Prosser contributes the Historical Review and Bibliography.

The lengthy chapter on the Lower Devonian Deposits is the work of Messrs. Schuchert, Swartz, Maynard and the late R. B. Rowe, each responsible for a special section, Mr. Schuchert for the general introduction, Messrs. Swartz, Maynard and Rowe for the determinative stratigraphy, Dr. Swartz for the formational correlation. All four have shared in the "Local Sections," a chapter with which the geological portion of the volume closes.

In the descriptive paleontology which follows, the chapters and their authors are these: Cœlenterata, by Dr. Swartz; Cystidea, by Professor Schuchert; Crinoidea and Vermes, by D. W. Ohern; Bryozoa, by Drs. Ulrich and Bassler; Brachiopoda, by Professor Schuchert and Mr. Maynard; Mollusca and Trilobites, by Messrs. Ohern and Maynard; Ostracoda, by Drs. Ulrich and Bassler.

Thus briefly are the contents of this volume 1 indicated, but only the stratigrapher and paleontologist will appreciate the penetration of these analytical studies. Perhaps a leading feature of the stratigraphy is that expressed by the authors of their conception of the "Keyser member" of the series and the discussion of its correlation value with contemporaneous Appalachian deposits elsewhere. This is a succession of homogeneous limey sediments with a thickness of several hundred feet which are assigned a place at the base of the Devonian system. The deposits are continuous into Pennsylvania, but their equivalents northward in New Jersey

and New York are known by other names, and the discussion of their correlation raises delicate questions of fact and interpretation.

A very distinctive part of the paleontological chapters is Professor Schuchert's treatise on the cystids, a somewhat expanded account of his earlier descriptions and illustrations of these genera and species which attained a noteworthy development in the "Keyser member." There are attractive novelties among the crinoids, fine Bassler-photos appear among the Bryozoa, familiar drawings among the profusion of brachiopods and Mollusca, very interesting trilobites, regarding which the writer ventures to intimate (by way of neutralizing too much blandiloquence) that *Homalonotus swartzi* Ohern (Pl. 90) is *H. vanuxemi* Hall (*vanuxemi-major-perceensis* type), that *Dalmanites keyserensis* Swartz (Pl. 91, Figs. 5, 8, 9) is *D. micrurus* Green and that the object figured on Pl. 92 (Fig. 3) as the hypostoma of *D. multiannulatus* Ohern is not an hypostoma, but the very interesting bifurcate anterior limb of the cephalon.

Volume 2 opens with a discussion of the Middle Devonian, its subdivision and correlation, the major part of which is by Dr. Prosser, who has, with his usual perspicacity and justness, discussed the characters of these sediments and their correlation values. The Maryland geologists have felt impelled to follow the usage of the U. S. Geological Survey in adopting the term "Romney" (West Virginia place-name) to embrace the members which in New York are known as the Onondaga, Marcellus and Hamilton. Each of these is a recognizable factor in the composition of the Romney although the Onondaga has a distinctly peculiar development in lithology. And, says Dr. Prosser, "there are obstacles in the way of attempting to map these divisions separately due largely to the gradual change from the lithological characters of one member to another. . . . It was thought best to regard the stages as constituting one formation." The distinctive character of the Onondaga member is a matter of much interest because of its essential departure from its calcareous expression at the north. Limestone deposition is largely replaced by black shales of the type of the Marcellus, and would, in the opinion of Dr. Swartz, who has contributed the special section on this formation, indicate the increase southward of the replacement which is already evident in western New York.

Dr. Kindle contributes a concluding and philosophical chapter on the relations of the faunas to the sediments.

The systematic paleontology of the Middle Devonian has been prepared chiefly by Drs. Prosser and Kindle, the Bryozoa by Drs. Ulrich and Bassler.

Thereupon follows a treatise on the Upper Devonian deposits by Drs. Prosser and Swartz, with the correlation essay and the local sections by Swartz, and finally the descriptive paleontology by Clarke and Swartz. The entire Upper Devonian series in Maryland is divided into a lower marine—the Jennings formation—and an upper non-marine—the Catskill. In the matter of stratigraphy and faunal succession the Maryland Upper Devonian shows a closer relationship with the carefully elaborated Upper Devonian of New York than is as yet known from any other region outside the latter. But even with this close affiliation it has seemed necessary to meet present requirements by interposing new stratigraphic terms. The black shale and peculiar fauna of the Genesee member at the base of this series stand confirmed, but above it the Portage beds with the Naples fauna and the higher Ithaca fauna are embraced by the term "Woodmont shale member." Overlying is the "Parkhead sandstone member" which seems, in place and fauna, to be equivalent to the Enfield member or Unadilla terrane of New York (*Ithaca* in its old and broader sense). The "Chemung sandstone member" has effectively the place and value of the Chemung in New York.

What has been thus said may serve to indicate in small part the purport and presentments of this work. Its collaborators have done honorably and with credit to themselves and their themes in perfecting an encyclopedia of a great geological system in an

important Appalachian field; by means of it correspondences and contrasts with the developments elsewhere of the Appalachian Devonian trough-seas are made more lucid. The writer feels at liberty to speak thus, as he frankly concedes that his part of the book, done ten years ago and laid aside, has been more appropriately attired by the generous labors of Dr. Swartz.

Though the writer's appearance in SCIENCE as reviewer of these volumes is due to the solicitation of its editor, he may take advantage of that fact to express the conviction, which will be shared by all students of the Devonian, that this work is a distinct credit to the science and its accomplishment an added honor to the distinguished head of the Maryland Geological Survey.

JOHN M. CLARKE

Technical Gas and Fuel Analysis. By ALFRED H. WHITE, Professor of Chemical Engineering, University of Michigan. Published by McGraw-Hill Book Company as one of the International Chemical Series. 1913. Pp. 255. $2.00 net.

The book contains seventeen chapters, the first twelve of which deal with gas analysis, the thirteenth with the analysis of liquid fuels, and the remaining four with the analysis of coal.

The methods described in the chapter on the sampling and storage of gases are open to objection in that water is used as the confining liquid. The author carefully emphasizes the fact that the water to be used must be saturated with the gas in question; but changes in temperature and changes in the composition of the gas are sufficient to change the amounts of the various constituents dissolved in the confining liquid. Such changes are to be expected when the gas sampling extends over an appreciable time interval, and render worthless the results of the analysis in the case of certain gas mixtures. There is no objection to using water in sampling gases of low solubility where extremely accurate results are not required, but such a condition does not frequently arise.

No description is given of the apparatus most commonly employed in technical gas analysis at the present time, *i. e.*, the original Hempel apparatus, the author's modification of both the burette and the pipettes being offered in its place. In the opinion of the reviewer, the Hempel apparatus deserves a prominent place in any text-book on gas analysis because of the simplicity of its manipulation and the rapidity with which results that are sufficiently accurate for most technical purposes may be obtained. The slightly greater accuracy obtainable with the White apparatus does not seem to warrant its general use when the longer time and greater inconvenience that are considered.

In the chapter on methods of explosion and combustion, emphasis should have been laid upon the necessity of employing mercury in the burettes that are used with the explosion and combustion pipettes, and in the combustion of methane over copper oxide, on account of the solubility in water of the carbon dioxide that is formed. In this connection, the statement on page 57 concerning the combustion of methane over copper oxide needs revision: "If the gas had been passed back and forth into a pipette filled with water during the combustion there would have been no change in volume, but since the gas was passed into the caustic pipette during the combustion process and the CO_2 was absorbed the contraction equals the methane." A similar sentence also occurs later on the same page.

In the discussion (p. 85) on the combustion of hydrogen, the author criticizes the method of Dennis and Hopkins on the basis of the formation of oxides of nitrogen, on what seems to the reviewer insufficient evidence that was published twelve years ago. He seems to have overlooked the results obtained by Rhodes.[1] These results show that the volume of the oxides of nitrogen that are formed when the combustion is properly performed is always less than .01 c.c., a figure so small as to be negligible.

The author dismisses the subject of the various improved forms of the Orsat apparatus recently placed on the market with a short

[1] Dennis's "Gas Analysis," page 153.

paragraph which closes with the following sentence: "There are decided objections to complication in any form of apparatus which may receive rough treatment in transportation and which is frequently handled carelessly by its operators." It is surprising to note that the author gives preference to a form of apparatus because it is able to withstand "rough treatment" and "careless handling," when it has repeatedly been shown that the apparatus gives erroneous results.

The chapter on exact gas analysis contains a description of two burettes designed by the author. The bulbed gas burette is an improvement over the Pettersson-Hempel gas burette for exact gas analysis with respect to the accuracy with which gas volumes may be read.

Under the methods for the determination of the heating value of a gas, the Junkers calorimeter is taken up in detail, brief mention is made of the Hempel, Graefe, Parr, and Doherty calorimeters, and one paragraph is devoted to the discussion of automatic and recording gas calorimeters. The material in this chapter is excellent. The use of the definition of what is known usually as "total" heating value to define the "gross" heating value is confusing, especially since later in the chapter there is given a table of corrections to obtain the "total" heating value from the observed or "gross" heating value. This chapter also includes a description of the sling psychrometer for determining moisture in air, since the moisture content is one of the variables upon which the value of the above correction depends. The whirling psychrometer is not mentioned.

There is a short chapter on the determination of suspended particles in gas, a subject which has hitherto not been given the prominence it deserves in books of this character. In the words of the author, this is a subject which "is daily becoming of greater importance on account of legal restrictions on pollution of the air and on account of insistence on closer control of industrial operations by manufacturers."

The remainder of the twelve chapters on gas analysis is devoted to a discussion of chimney gas, producer gas, illuminating gas and natural gas, including methods of analysis and the application and interpretation of the results.

The chapter on liquid fuels is short and not so comprehensive as one would expect from the title of the book.

Under coal analysis, there is one chapter on sampling, one on the chemical analysis and two on the determination of the heating value by various methods. Frequent references are made in these chapters to the results of the investigations of the Joint Committee on Coal Analysis of the American Chemical Society and the Society for Testing Materials, of the Bureau of Mines and of the Bureau of Standards.

Typographical errors occur occasionally, *e. g.*, Ernshaw for Earnshaw, page 81, napthalene for naphthalene, pages 164 and 169, and Kjehldahl for Kjeldahl, page 210; there is a lack of punctuation, especially of commas, which renders some of the sentences ambiguous; peculiar constructions are present, *e. g.*, "Chapter II. describes the apparatus which the author believes best adapted to technical gas analysis and gives detailed directions for its manipulation," page 61, and "These gases (sulphur dioxide and sulphur trioxide) are absorbed, oxidized to sulphuric acid and weighed as barium sulphate," page 162; and finally, "estimation" is used throughout the book in place of "determination."

The book is well illustrated; all determinations that involve computations are clearly explained by the aid of concrete examples; and eight useful tables are appended at the close.

R. P. Anderson

Cornell University,
Department of Chemistry,
October 24, 1913

PROFESSOR NOGUCHI'S RESEARCHES ON INFECTIVE DISEASES[1]

The Royal Society of Medicine mostly limits the record of its work to its own *Proceedings* and the medical journals; and it does well to observe this wise rule. But from

[1] From *Nature*.

time to time it receives some communication of the highest importance to the general welfare, and on such occasions it is mindful of its immediate duty to the public. It lately held a special meeting, at which Professor Noguchi, of the Rockefeller Institute, demonstrated the results of his researches into syphilis, general paralysis of the insane, epidemic infantile paralysis and rabies. None who heard Professor Noguchi and saw the great crowd of physicians and surgeons listening to him could fail to recognize the profound significance of this occasion

No man of science works alone or in isolation: and a vast amount of cooperative work is being done in diverse parts of the world on what may be called the "higher types" of germs. Let us note the development of the work. Let us go back half a century, to the earliest methods of Pasteur. We may take 1855 as an approximate date for the beginning of the founding of "the germ-theory." For many years the only method which Pasteur had for the growth of germs in pure culture was the use of fluid media, such as broth; and, under the conditions of bacteriology fifty years ago, the use of these fluid media was full of difficulties. He had to wait until 1872 for the discovery that germs could be grown on solid media, such as gelatine or slices of potato. He had to wait until 1875 for the discovery that germs could be stained with aniline dyes so as to distinguish them, under the microscope, from their surroundings.

Pasteur lived until 1895—that is, ten years after the first use of his protective treatment against rabies, and two years after the first use in practise of diphtheria antitoxin—but he did not live to see more than the beginning of the study of the higher types of germs. At the time when he died, many of the lower types—the bacilli and the micrococci—had been discovered, isolated, grown in pure culture on solid media, and proven, by the inoculation of test animals, to be the very cause of this or that infective disease. But the higher types, such as the *plasmodium* of malaria, were still waiting to be worked out. Then, after Pasteur's death, came Ross's fine work on malaria; and then came two discoveries of no less importance—the discovery (Schaudinn, Hoffmann) of *Spirochæta pallida* in cases of syphilis, and the discovery (Forde, Dutton) of *Trypanosoma gambiense* in a case of sleeping sickness. These two discoveries brought syphilis and sleeping sickness, at last, within the range of practical bacteriology. Long ago, Moxon had said of syphilis that it was "a fever cooled and slowed by time"; but the cause of that fever was unknown until the *Spirochæta pallida* was discovered.

But to prove that it does not merely accompany, but actually causes the disease, it had to be grown in pure culture, and inoculated into test animals, producing in them some characteristic sign. Syphilis must be studied as diphtheria, tetanus, typhoid fever and tubercle had been studied. That is the meaning of all the work done by Ehrlich and his school upon salvarsan—that, in particles of tissue from a rabbit in which the disease has been produced, the *Spirochæta pallida* is present, under the microscope, before a dose of salvarsan, and is absent after it.

The work has been of immeasurable complexity, and there is much still to be done. There are many species of spirochætes discoverable in this or that condition of bodily life, besides *Spirochæta pallida;* indeed, Professor Noguchi demonstrated seven species. But he has cleared the way in this field of bacteriology. He has distinguished those which need some air for their growth from those which can not grow in air; he has discovered the method of adding a fragment of sterilized animal substance to each tube of pure culture: and these methods are of great value.

But that is not all. For he has detected *Spirochæta pallida* in the brain, in general paralysis of the insane. He has found it in twelve out of seventy specimens. There is no need to underline the importance of that statement.

Also, Professor Noguchi has obtained in pure culture the germs of anterior poliomyelitis (epidemic infantile paralysis). Of all the

many diseases of childhood in which the art of medicine, apart from its science, is of no great use, few are more unkind than infantile paralysis. It is the Rockefeller Institute that we must thank here. First came Flexner's magnificent work on epidemic cerebrospinal meningitis, and his discovery (1908) of the special antitoxin for that disease; then came the study of epidemic infantile paralysis. To have in one's hands, in a test-tube, infantile paralysis, is a grand experience for a man who has attended a children's hospital, year in year out, long before the Rockefeller Institute was born or thought of. It is enough to make him believe that the doctors some years hence may be able to stop the disease before it can inflict irremediable injury on the nerve cells of the spinal cord.

Finally, Professor Noguchi spoke of rabies (hydrophobia). He has been able to obtain, in pure culture, the microscopic bodies which Negri discovered in the brain in that disease. He demonstrated to the Royal Society of Medicine, on the lantern-screen, photographs showing the cycle—not unlike that of the *Plasmodium malariæ*—through which these bodies pass until, like miniature shrapnell, they break, setting free their constituent granules; and each granule becomes a "Negri body," and starts the cycle again. Happily, the protective treatment against rabies did not have to wait for the discovery of these Negri bodies. Pasteur worked at rabies, as Reed and Lazear worked at yellow fever, knowing that the virus was there, and able to control, fight and beat it, without seeing it under the microscope.

The Royal Society of Medicine deserves the thanks of the public for inviting Professor Noguchi to give this demonstration in London. He is indeed, in width and originality of work, equal to his fellow-countryman, Professor Kitasato. He has helped to make it possible for men of science to extend to other diseases those methods of study which brought about the discovery of diphtheria antitoxin and the protective treatments against cholera, typhoid fever and plague.

Stephen Paget

DIATOM COLLECTION OF THE UNITED STATES NATIONAL MUSEUM

Dr. Albert Mann, author of the "Report on the Diatoms of the *Albatross* Voyages in the Pacific Ocean" and many other diatom papers, has recently been appointed custodian of the diatom collection of the United States National Museum. This collection already contains much valuable material, including the types of species accumulated by the late Professor H. L. Smith, of Geneva, New York, the specimens of all the species of the *Albatross* diatoms, and the extensive collection of diatom material of the late Professor C. Henry Kain, of Philadelphia, representing the principal fossil deposits throughout the world as well as a large number of recent gatherings made in this country and abroad. To the large amount of material thus brought together, there are being added the marine diatoms of the Shackleton Expedition to the South Pole, diatoms recently secured in the Panama Canal Zone by the Smithsonian Institution, and the pelagic coastal diatoms of the Atlantic seaboard now being collected under the auspices of the Cambridge Zoological Laboratory and the United States Bureau of Fisheries.

For the accommodation of the extensive series of specimens thus assembled a separate room in the National Herbarium has been fitted up with cases, microscope accessories, and other necessary apparatus. The action of the National Museum in thus affording proper facilities for diatom study is in accordance with a growing realization of the importance of these organisms in modern science. Until recently they were appreciated mainly because of their artistic beauty and their interesting microscopical structure. They are now coming to be recognized as constituting one of the fundamental food supplies of the marine world and as having an important bearing on oceanography and recent geology.

Collectors who donate diatom specimens to the National Museum may be assured that their collections will be carefully preserved and made available to diatom students. The number of types already brought together is

sufficiently large to insure a permanent value to this collection, and to warrant an attempt to make it as complete and comprehensive as may be practicable.

FREDERICK V. COVILLE,
Curator of Botany

SPECIAL ARTICLES

REVERSIBILITY IN ARTIFICIAL PARTHENOGENESIS

I

IN 1900 the writer pointed out that in *Campanularia* a highly differentiated organ like the polyp may be transformed into the less differentiated material of the stem, which in turn may form a new polyp.[1] Since then, reversibility of certain phenomena of differentiation has been observed by Driesch, Child, F. Lillie, Schultz and others.

The writer has repeatedly tried to reverse the phenomena of development in the egg of *Strongylocentrotus* fertilized with sperm but thus far without success. Experiments on artificial parthenogenesis, however, gave positive results.

It is difficult to cause artificial parthenogenesis in the eggs of the Californian sea urchin with hypertonic sea water. If we treat these eggs for about 2 or 2½ hours with such a solution (50 c.c. sea water + 8 c.c. 2½ *m* $NaCl + CaCl_2 + KCl$) it often happens that a certain percentage of eggs, after they have been returned to normal sea water, begin to segment regularly in 2, 4 or even 8 or 16 cells. They then stop developing and go into the condition resembling that of a resting egg. If such blastomeres are at any time fertilized with sperm they will develop into larvæ in a perfectly normal way.[2] These observations show incidentally that it is not the lack of the organs of cell division which prevents the unfertilized eggs from developing, since these eggs had been in possession of these organs.

The writer has shown that the induction of development in the egg is due to a combination of at least two agencies. The one causes an alteration of the surface (which may or may not be followed by a membrane formation) and this alteration starts the development of the egg, but leaves it, in many cases at least, in a sickly condition from which it can be freed by the application of the second, corrective agency. The alteration of the surface may be caused by any of those substances or conditions which cause hemolysis: acids, bases, hydrocarbons, hypertonic and hypotonic salt solutions, foreign blood, etc. The second, curative effect may be produced by a short treatment of the egg with a hypertonic solution or by a suppression of the development of the egg for a somewhat longer period by lack of oxygen or by KCN. One method of causing artificial parthenogenesis in the eggs of *Arbacia* consists in putting them for about 20 minutes into a mixture of 50 c.c. $m/2$ $(NaCl + KCl + CaCl_2) + 0.3$ c.c. $N/10$ NH_4OH and subsequently into a neutral hypertonic solution for from 15 to 20 minutes (the figures are given for about 22° C.). A varying percentage of eggs treated this way will develop into embryos and the rest will perish very rapidly. If the eggs are treated with the alkaline solution alone without subsequent treatment with the hypertonic solution they will begin to segment, but they will perish rapidly. The alkaline treatment alone induces the change in the surface of the egg required to start the development, but this, without the corrective treatment, leads only to the first segmentations followed by a rapid disintegration.

The writer found last summer that these effects are reversible in the eggs of *Arbacia.* If, after the treatment with alkaline solution alone or with alkaline and hypertonic solution, the eggs of *Arbacia* are put for a sufficient length of time into sea water containing a certain amount of NaCN or of chloralhydrate, they go back into the resting stage and behave in appearance and reaction like unfertilized eggs. Both the NaCN and the chloralhydrate prevent the developmental processes in the egg. The suppression of these processes of development reverses the changes induced in the egg by the treatment with alkali. If after

[1] *Am. Jour. Physiol.*, IV., 60, 1900.

[2] *Arch. f. Entwicklgsmech.*, XXIII., 479, 1907; *Jour. Exper. Zool.*, XV., 201, 1913.

a sufficient length of time such eggs are removed from the sea water containing NaCN to normal sea water they neither segment nor disintegrate, and if sperm is added they will develop into normal blastulae. If the eggs remain only 20 minutes in the alkaline solution a very short exposure to the NaCN solution suffices. The longer the eggs remain in the alkaline solution the longer they must also remain in the cyanide solution if the effect of the alkaline solution is to be reversed. If they remain too long in the alkaline solution a subsequent treatment of the eggs with NaCN will only temporarily suppress the effects of the alkali, but as soon as they are put back into normal sea water they will disintegrate or develop. In this case the effects of alkali become irreversible.

What has been said for the effects of the alkali is also true for the effects of acid. If we cause artificial membrane formation by butyric acid in the eggs of *Arbacia* (without submitting them to the second treatment) they will begin to develop, but will disintegrate very rapidly. If they are put after the membrane formation for some hours into a cyanide solution they will go back into a resting stage. When transferred to sea water they will neither segment nor disintegrate, and when fertilized by sperm they will develop into normal larvæ.

It is therefore obvious that the induction of development in the egg of *Arbacia* by acid or by alkali is a reversible process.

II

The question arises: Which of the two factors is reversible, the surface change (or its effect in inducing development) or the corrective factor, or both? The experiments show plainly that the first factor is reversible. In this respect the eggs of *Arbacia* differ from those of *Strongylocentrotus*. In the latter the writer succeeded in suppressing temporarily the disintegration following artificial membrane formation by the suppression of development with KCN, but the eggs when put back into normal sea water either developed or perished. There was no such reversion of the induction to development as we find in the egg of *Arbacia*. This difference in the behavior of both kinds of eggs is possibly connected with a difference in the degree and possibly also the character of the alteration of the cortical layer under the influence of butyric acid. This is indicated externally by the difference of the membrane to which the writer had called attention in previous publications. While both types of alterations of the cortical layer induce development, in the egg of *Arbacia* this change is of a degree or character so as to be reversible, while in the egg of *Strongylocentrotus* it is irreversible as far as my present experience goes. When the eggs of *Arbacia* are exposed too long to the alkaline solution the change induced becomes also irreversible.

In the egg of *Strongylocentrotus* the corrective factor is, as the writer has recently shown, irreversible. When eggs, once treated with a hypertonic solution which does not alter them visibly and which leaves them intact, are at any time after one or two days treated with butyric acid, they will not disintegrate, but develop in the same way as if the hypertonic treatment had been applied *after* the membrane formation. I have not yet tried whether or not the same is true for the egg of *Arbacia*.

III

It is impossible to state at present what the nature of the reversible change is. The idea has been expressed by R. Lillie that the inducement of development (membrane formation) consists in a rapid increase of permeability and that the action of the hypertonic solution is to restore a normal condition of permeability in the egg.[3] If this were the case, the simultaneous application of the alkaline and hypertonic solution should leave the egg wholly or nearly intact, while in fact it is just as effective as if we treat the egg first with an alkaline solution and then with a hypertonic solution. Moreover, the hypertonic solution itself induces an alteration of the surface of the egg (membrane formation) which in the terms of this hypothesis would

[3] Lillie, *Jour. of Morphol.*, XXII., 695, 1911.

be interpreted to mean an increase in permeability. Finally, the treatment of the egg of *purpuratus* with a hypertonic solution may precede the artificial membrane formation by one or two days. According to Lillie's hypothesis, NaCN should diminish the permeability of the egg. Direct observations by Wasteneys and myself have shown that NaCN does not influence its permeability.

The reversion of the induction of development is clearly the outcome of the suppression of the developmental changes in the egg by NaCN or by chloralhydrate. During this period of rest the cortical layer may return permanently to a condition resembling that of the normal resting egg. Since fertilization by sperm, artificial membrane formation, and destruction of the egg by cytolysis, all raise the rate of the oxidations in the egg of *purpuratus* by the same amount, the clue to the explanation of the phenomena of reversibility may possibly be found in those conditions of the cortical layer which have to do with the increase in the rate of oxidations after membrane formation.

JACQUES LOEB

THE ROCKEFELLER INSTITUTE
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NEW YORK

SOCIETIES AND ACADEMIES

BIOLOGICAL SOCIETY OF WASHINGTON

THE 414th regular meeting was held in the assembly hall of the Cosmos Club, October 18, 1913, with former President L. O. Howard in the chair and 61 persons present.

The program consisted of three communications:

I. *The Federal Migratory Bird Regulations and their Assistance in the Conservation of Bird Life in America:* T. S. PALMER.

The speaker outlined briefly the history of the Weeks McLean bill, approved March 4, 1913, and of the adoption of regulations for its enforcement which have been promulgated by the Department of Agriculture under proclamation of the President dated October 1, 1913. Maps of the winter and breeding ranges of some of the species of birds affected were shown, together with another showing the division of the country into two zones. Reasons were given for the exceptions in certain states to the general closed season. In general the beneficial effects upon the bird life of the country expected as a result of the enforcement of the federal law were pointed out.

Hugh Smith and Col. Joseph H. Acklen took part in the discussion which followed.

II. *The Breeding of the Loggerhead Turtle:* W. P. HAY.

The communication was accompanied by lantern slides. It was an account of observations of the habits and reproduction of the diamond-backed terrapin and the loggerhead turtle made at Beaufort, North Carolina. This place is near the northern limit of the distribution of the loggerhead turtle and the speaker was of the opinion that normally in this latitude few of the eggs of the species are left to hatch and that the young from those that may hatch all perish with the first cold weather.

III. *The First Year's Results in Breeding Some Bahama Shells (Cerion) on the Florida Keys:* PAUL BARTSCH.

A former communication by the speaker gave an account of the transfer of two races of *Cerion* from the Bahamas to various Florida Keys. The present paper was an account of observations of the condition of the new colonies at the end of the first year. In general they have prospered and in several localities have reproduced young.

The 515th meeting was held in the hall of the Cosmos Club, November 1, 1913, with President E. W. Nelson in the chair and about 50 members present.

Under the heading "Brief Notes and Exhibition of Specimens," C. Dwight Marsh related an observation in Montana of a noise made by a bull snake (*Pituophis sayi*) which was in close imitation of that made by a rattlesnake. The sounds were made by the respiratory organs and were observed by a number of persons.

The regular program follows.

A. D. Hopkins spoke of Depredations by Forest Insects and their Control. He gave a brief historical sketch of early insect invasions of forests and of the means adopted to combat the pests. The greater part of the paper was devoted to depredations of which the author had personal knowledge. The efficacy of modern methods was pointed out, especially the control work undertaken by the Bureau of Entomology in collaboration with the United States Forest Service. These have been generally adopted by large private holders of timber lands and much saving of valuable timber has resulted.

Paul Bartsch gave an account of the results of dredging for mollusks at Chincoteague, Virginia. In two days collecting eleven new species were found. The speaker gave an account of some personal experiences and observations on the island. He was followed by W. P. Hay, who also spoke of his experiences during a visit to Chincoteague and gave some interesting historical notes of the place.

D. E. LANTZ,
Recording Secretary

ANTHROPOLOGICAL SOCIETY OF WASHINGTON

A SPECIAL meeting of the society was held, October 28, in the National Museum building at 4:30 o'clock.

Dr. Aleš Hrdlička addressed the Society, his subject being "The Results of the Speaker's Recent Trip to Peru; with Remarks on the Anthropological Problems of Peru"; illustrated with lantern slides. In 1910 Dr. Hrdlička made a brief exploratory trip in Peru, which resulted in the acquisition of some valuable data and of important skeletal collections. The opportunity to extend the investigations came during the early part of the current year, in connection with the preparation of the anthropological exhibits for the Panama-California Exposition at San Diego; and as a consequence three busy months were spent on the Peruvian coast and in certain parts of the mountain region of Peru, in exploration of the ruined cities and ancient cemeteries. The principal objects of the trip were, first, the mapping out as far as possible of the anthropological distribution of the prehistoric Peruvian, more particularly the coast people; second, the determination of the physical type of the important Nasca group of people, which represent one of the highest American cultures; third, further inquiry as to man's antiquity on the west coast of South America, and fourth, the extension of the speaker's researches on pre-Columbian pathology. The conclusions to which the speaker was formerly led were in the main corroborated. In regard to the mountain regions much remains to be determined in the future. As to the pathology of the native Peruvian before contact with whites, the main work can perhaps be now regarded as done, or nearly so, although individual variation in different morbid processes seems inexhaustible, and much in this line remains to be secured by future exploration. The ground covered was extensive and the skeletal material examined was enormous, the selections alone filling over thirty boxes. No excavation was practised, attention being restricted, on the coast, to the bones covering the surface of ancient cemeteries, exploited by the peons, and to burial caves and houses in the mountains.

Since the speaker's trip to Peru three years ago, a change for the worse was observed in the state of preservation of the ancient remains. Also, where formerly there were seemingly inexhaustible quantities of skeletal material there is now a dearth of it. No such collection as that made in 1910, when the speaker gathered 3,400 important crania, will ever again be possible from these regions. The major part of the old population of the coast region belongs to the brachycephalic type intimately related to the Maya-Zapotec type in the north. Wherever they lived, these people of the Peruvian coast were wont to practise, more or less, the antero-posterior head deformation. Everywhere along the coast there are evidences of more or less admixture with a more oblong-headed element closely related to the Aztec and Algonquin types of North America. As among the North American Pueblos, nowhere was the aboriginal Peruvian population at any time as great as the relatively numerous cemeteries or ruins might lead one at first to suppose, for these burial grounds and ruins date from different, although not far distant, periods.

The work now done, while to some extent establishing a foundation, is merely a fair beginning. Similar investigations and collections by the anthropologist are urgently needed in the important districts of Piura, Eten and Moquegua, on the coast; in the western sierras from the neighborhood and latitude of Quito to those of Arequipa; and in the eastern highlands from Tiahuanaco to Moyobamba. The most important problems that await solution are (1) the derivation of the Peruvians; (2) the time of their advent into the country; (3) the extension and exact physical characteristics of the Aymara and Quechua, and (4) the genetic relations of the Peruvian to the Argentinan and Chilean aborigines. Besides this there remains to be established in many places the correlation of culture with the physical type of the people. The speaker repeats what he said in a former report, that, due to the lack of scientific supervision of a great majority of the excavations practised in Peru to the present time, the archeological collections from that country are made up of little more than curiosities which it is in most instances impossible to refer either to any definite tribe or period.

DANIEL FOLKMAR,
Secretary

SCIENCE

FRIDAY, NOVEMBER 28, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

FEDERAL FORESTRY[1]

THE part played by the nation in forestry must always be large. Here as in all other countries, the real development of forestry began when the government took up its practise. Even to-day some persons would leave the forests entirely to private owners; others insist that the public phases of forestry are altogether a state function and federal activities in this field uncalled for. Those who hold this view are usually either lukewarm concerning the need for forest conservation or opposed to restricting private activities.

National responsibility in forestry is perfectly clear-cut. There need be no confusion with an equally clear-cut responsibility of the states. And as to private forestry little of value has so far been done that has not been an outcome of public action through state or federal agencies, or both. It was the work of the federal government in placing its own forests under administration, its demonstration of fire protection and of conservative lumbering, its experimental and educational work, and its stimulus to our educational institutions to train and turn out a large body of foresters, which created the present wide interest in forestry and brought the efforts of other agencies into successful play. I do not mean in any way to overlook the splendid work of certain individual states like Pennsylvania and New York, which dates back many years. But that was localized in a few states. It required the nation itself to set in motion a national move-

[1] Address delivered at the Fifth National Conservation Congress, Washington, D. C., November 19, 1913.

ment. The national work will always be the backbone of American forestry, not trenching on or interfering with state work or individual efforts but serving as a demonstration of forest management on its own lands, a center of leadership, cooperation and assistance to state and private work, a means to handle interstate problems and coordinate the work of neighboring states, a guarantee that national needs which individual states can not meet will be provided for on a national scale.

Underlying the forestry problem are two fundamental considerations which should be emphasized and reiterated until thoroughly driven home. One is the public character of forestry. The public has a peculiar interest in the benefits of forestry. Both in the matter of a continued supply of forest products and in that of the conservation of water resources the public welfare is at stake. In each case purposes vital to the prosperity of the country can be accomplished only with the direct participation of the public. Private owners will secure results only on a limited scale in the long run on their own initiative. It takes too long, 50 to 200 years, to grow a crop of timber trees. Most private owners in face of fire risk, bad tax laws and uncertain future markets will not make the necessary investments. Most lumbermen have bought their lands either to log or to speculate in the standing timber, not to grow trees for later generations. Nor will private owners make investments for general public benefits, as in watershed protection. If the public is to secure the benefits of forestry it must take the measures necessary to guarantee these results, and it must bear the cost of what it receives.

Closely related to the fact that forestry is in many aspects a public problem is the second of the fundamental considerations I wish to emphasize. Forestry requires stability of administrative policy and such permanence of ownership as will ensure it. Herein lies the difficulty of private forestry on a large scale. Timberland owners are interested in the protection of their standing timber merely as insurance. Most of them are not interested in forest production, or in protecting cut-over lands if that involves substantial annual charges and is not necessary in order to protect their remaining standing timber. As yet the problem of cut-over private lands is unsolved. It is now devolving on the state to aid in their protection from fire in the interest of its own citizens. It will require the utmost resources of state and federal government together to handle this problem of getting reasonable protection of private forests and permanent production of timber on cut-over lands. Stability of policy and permanence of ownership are essential to any successful attack on this great conservation problem.

This principle of stability of policy of administration is a large factor in successful handling of public property and has been consistently considered in the national forest work. I am frequently asked as I travel about the country whether I am going to make important changes in the forestry policy. I was asked that very often in 1910, when I first took office. I am asked it often this year. My answer is that what we are seeking is not changes but the development of a permanent public enterprise with consistent and stable policies. The national forests were set aside in the recognition that the bulk of these lands should be handled permanently under public protection and control. Provision was made for the acquisition of agricultural lands that might best be developed under private ownership, and such areas are now being classified and segregated from the forests very rapidly. The

successful handling of the national forests requires annual expenditures in administration and protection and in development of roads, trails, telephones, buildings and other improvements necessary for proper administration. We seek, therefore, as fast as possible to develop through classification the permanent boundaries of the forest land, and the management of it according to definite far-sighted plans that will make for the best results of all expenditures in the long run. The result sought is an efficient business administration, a proper and adequate forestry practise, and development of the public property in the interests of the people who own it. These simple principles have been kept in mind since the first organization of the work by Mr. Pinchot, who was more than any other one man responsible for what has been accomplished in forestry in this country.

The national forests have now been under administration fifteen years, and under the Forest Service for eight years. The aim of the present administration is not to overturn, but to take every possible step to increase efficiency of the organization, to adjust difficulties, and advance as fast as possible the purposes for which the national forests were established. Secretary Houston recently said to me regarding the national forests:

"Establish permanent boundaries. Classify your lands; segregate the agricultural land and fix right limits for what is needed as protective and productive forests. Develop permanent policies based on full recognition of lasting public interests, and settled forestry practise fitted to the individual needs of each forest and locality. Study efficiency; make any changes necessary for this purpose, but make no changes that are not clearly called for in the public interest. Carry out your plans for the development and increasing use of the forests; but above all, make each forest work for community upbuilding and local as well as general welfare. We must always have in mind the men and women who are building up a new country and laying the foundations for prosperous, thriving commonwealths. We must try to study their needs and see where and how the forests can help them. But we must not cease to guard effectively against the evils of private privilege and monopolistic control of resources now the property of the public."

The first important result of national forestry is a demonstration that the forests can be protected from fire. It was only a few years ago that many asserted this to be impossible. In the northwest the smoke season was as inevitable as the rainy season of winter, and this was not merely the result of clearing land but from forest fires. It is only recently that our own forest officers have regarded lookout stations as feasible in certain places; for lookout stations are useless if smoke hides the view. This year has been the worst in many respects of all years in California because of the frequency of lightning fires. Yet the lookout stations on only two forests, and then only for a short time, were out of commission because of smoke; and the smoke came from fires on private lands. This year in California there were over 1,100 fires on the timbered areas. These were kept down to an average of a little over 20 acres per fire. This was done by an effective fire organization and through the means of the trails, telephones and lookout system. In one storm lightning set over 20 fires on one forest. It takes swift and efficient work to handle such a situation. The results so far attained show that fires can be mastered. But it is necessary first to put the forest in a condition to enable

the force to prevent fires, to detect promptly those which start, and to reach them quickly. The Forest Service is developing a system of lookout stations, fire lines, trails, and telephone lines that ultimately will make the forests secure. Already the force is able to save every year property valued at many million dollars through the improvements so far built, although as yet only a beginning has been made. This work is carried on according to a definite plan, already projected in detail. Each year's work adds 2,500 miles of trails, 3,500 miles of telephones, and many lookouts and other improvements, progressing toward the final scheme. Until that is completed the forests can not be made entirely secure. With that development, the forest fires can be handled even in that exceptionally dry year that occasionally comes to every region.

This protection not only saves the trees from destruction or injury, but already the effect is shown in the restocking of many areas where the old fires had prevented reproduction. Personally, I had hardly expected that there would be so quick a response. But the results are now apparent to even a casual observer. More specifically, while previously the forests were going backward because of fires, there is now an annual gain through growth. This increase translated into dollars and cents is much greater than the total cost of protection and all other expenses of the forests.

The necessity to take immediate steps to prevent the public forests from being destroyed by fire has placed a large emphasis on the protective feature of the administration. The wise use of the forest resources in the development of industries and in building up the country is essentially the real aim of maintaining the forests. Protection from destruction is a first essential; otherwise there would be no resources to use. But the purpose of the administration is not merely protective, but constructive. It is a favorite theme of the opponents of the national forest system to represent the forests as a separate federal domain, held for the use of future generations or for persons other than those now living in the region in which the forests are situated. Such statements are not only contrary to the spirit of the administration of the forests, but are disproved by the results already being secured. The aim is to make the forests count in the highest possible measure in the industrial upbuilding of the local communities, at the same time that they serve their broader public functions. In classifying the agricultural lands the aim is to get people to make permanent homes in the forests. Every consideration in the development of the states and in the upbuilding of the forests themselves makes for the encouragement of a greater local population. When there are people to create a demand for the timber and other resources, the real development of the forest becomes possible, and the forest begins to render its greatest service.

To encourage this development the Forest Service is promoting the sale of its ripe timber to build up local lumber industries of a permanent character; it is opening to entry land chiefly adapted to agriculture; it is further helping the settler by providing free such timber as he needs and protecting him in the use of the range needed for his stock; and in every way it undertakes to make the forests of public service and the country in the long run a better place for men and women to live in.

That a long step has already been taken toward this end is indicated by the very extraordinary change in sentiment in the west in the last few years. I have this year

been able to analyze in detail the sentiment on the individual forests and now know just where opposition in each case exists and the extent to which the work of the federal government is valued. I have been astonished at the overwhelming preponderance of sentiment among the local communities in favor of the forest system. Frequently there are objections to certain regulations, or difficulty and friction in specific transactions. But every year these local troubles are being adjusted on the ground. There is still definite opposition to the forest system and the principles of our administration from certain groups, and certain interests. There are still certain water power interests which are carrying on a fight against the Forest Service. Many speculative interests oppose the forest system because the resources are not open to private acquisition under the general land laws. Certain men are opposed to the national forests because they can not secure privileges that would be possible if the forests were unprotected. For example, in the southwest I find a well defined opposition among those who desire to run herds of goats on the forests without restriction. The desire to secure valuable timber for speculation is now, and always will be, a source of opposition to the public control of our forests.

One proof of the present favorable sentiment is the fact that there are now relatively few breaches of the regulations. For example, in the fourth administrative district, which includes Utah, Nevada, northern Arizona, southern Idaho and southwestern Wyoming, over 11,000 permits were issued last year, each involving some regulation. There were only 35 cases of trespass, about half of which were innocent and the majority of the remainder not very important. Such a record would be absolutely impossible if the people themselves were not right behind the regulations. In other words, it was public sentiment that made it possible to carry out the procedure with such success.

In the national forest districts it is now seen that the aim is to make the national forests serviceable at present as well as in the future, and people are cooperating more and more with the government to make the local administration successful.

In the east the work of the federal government is to-day far more effective than ever before. The establishment of national forests under the provisions of the Weeks law is accomplishing many results not anticipated even by its most earnest advocates. The purchase of lands on important watersheds in the White Mountains and southern Appalachians is steadily progressing. Already contracts for over 700,000 acres have been approved by the National Forest Reservation Commission. These lands are located on the most important watersheds and have been secured at prices representing their actual value, the average being $5.07 per acre. It has already been demonstrated that the building up of national forests by purchase and at reasonable prices is practicable.

The first effect of these purchases has been an educational one. The wide interest in the work has resulted in an awakened appreciation of forest protection and forestry wherever the government has been examining land for purchase. Cooperation in forestry between the government and the states has received a great stimulus. The actual annual saving from loss on areas protected from fire directly as a result of the Weeks law, on private as well as public property, would amount to a very large aggregate sum. In short, the Weeks law is now yielding results which fully justify the new policy which it established.

The nation's interest in the success of the forestry movement is very great; the contribution of the nation through federal agencies should be correspondingly liberal. Let the federal government assume its full responsibilities of leadership, assistance and cooperation, and our forest problem will be on the way to certain solution.

HENRY S. GRAVES
FEDERAL FOREST SERVICE,
WASHINGTON, D. C.

THE ESSENTIALS OF AN EDUCATION[1]

THE official recognition of the subject of mental hygiene by the International Congress on School Hygiene is an important event, indicating formal assent to the principle that thought and conduct can only be intelligently discussed when considered in relation to all other forms of human activity. After having been perpetuated for centuries by mechanical repetition, the phrase "a sound mind in a sound body" has suddenly acquired a vital meaning for our civilization.

Although the honor of presiding at this symposium upon mental hygiene is deeply appreciated by me, I am keenly alive to the fact that the force and set of the currents in this movement are already so strong that the question of merit in the selection of your chairman is almost a negligible factor.

The common elementary truths of daily life are frequently either ignored or forgotten. "We go to Switzerland," said Lowell, "to learn the sun rises and to Italy to find out the sky is blue." In considering what the aims and methods of obtaining an education should be, our attention is so often fixed upon remote unattainable ideals that the really essential factors in the problem are overlooked. The cause of idealism in education, as well as in other matters, is often best served by those who take a direct practical interest in the problems of everyday life. It is an exceedingly dangerous form of sophistry which has recently been promulgated that tends to cast suspicions upon any system of education reflecting either utility of purpose or immediate practicability of application. The value of ideals is commensurate with their practical usefulness, unless we assume with the Buddhist that the *summum bonum* of human existence is found in passive contemplation. Mr. Snedden, the Massachusetts commissioner of education, in his recent book[2] affirms that many of our academic studies are organized and presented too much with reference to their pure aspects —that is, without regard to their application in contemporary life and activity.

Clear ideas in regard to some of the chief characteristics of the educational process will be of material assistance in restating the entire problem of educational reform in terms that shall be favorable, and not antagonistic to a rational solution. The successful execution of this plan will ensure the perpetuation of popular government. A distinguished writer recently indicated the direction in which all our hopes for the improvement of political and social conditions lie by affirming "the most important problem of democracy is the education of the citizen."

No intelligent person would dissent from the view that the process of education is intended to direct or shape the activities of living beings. Unfortunately, the tendency of the human mind either to contemplate events in the past or to speculate about the future has hitherto left man little time or opportunity to study his own activities or

[1] Chairman's address, "Symposium on Mental Hygiene," Fourth International Congress on School Hygiene, Buffalo, August 25 to 30, 1913.

[2] "Education Readjustment," Houghton, Mifflin Co., 1913.

to think about his immediate needs. Even in our universities comparatively little interest is given to the study of man as he lives, moves and has his being to-day.

The process of education should prepare students for life and not convert them into receptacles for storing up miscellaneous forms of information. If we succeed in grasping the vital principle concerned in this distinction, we see that the discussion of such questions as whether science or the humanities have the greater educational value are as absurd and futile as Don Quixote's attacks upon the windmills. The problems of "living" can not be expressed in pedagogical phraseology. An intelligent discussion of the activities of living beings and the methods to be used in directing them is only possible in terms of biology.

Education or, as it has often been defined, the intelligent direction of human activities, is a process, the successful adaptation of which to human needs should be measured by the effects on the entire life of the individual, and not merely by results observed during the very restricted period beginning with the entrance into school and ending upon graduation from college.

When judged from this standpoint, education is the intelligent assistance given to an individual to estimate his own capacity to adjust life at the level within which he may live happily and successfully.

As a corollary to these premises, it becomes obvious that those deserving the title of educators should have some knowledge of the fundamental characteristics of living beings. Man, as we all know, is an exceedingly complex organism, made up of many different parts or organs adapted for special vital functions. The harmonious interaction of all these organs, and the contact of the individual with his environment, are established and maintained by the sense-organs, as well as the brain and nervous system. Interference with the function of a sense organ, the internal viscera, or the brain and nervous system, causes an imperfect adjustment of the individual's life and a condition called disease is the result.

The brain and nervous system are important parts in the mechanism of adjustment, but the trends given to our activities are largely determined by other organs. The distinctive mental qualities of men and women, as reflected in the personality, are therefore not only due to differences in the brain and nervous system, but depend upon the influence exerted upon the processes of adjustment by internal organs. This fact has recently received striking experimental confirmation. Without entering further into the discussion of this interesting question, we merely wish to emphasize the necessity of considering all questions relating to the education of the personality from the broad biological standpoint. The personality represents the focus of all our activities and therefore if we desire to study its genesis and to direct its development we should not restrict our view of education to a psychologic basis. It is one task, and a very important one, to attempt to analyze mental traits, but it is quite another to determine whether specific personal characteristics are not due to excessive secretion of the thyroid gland, a dilated heart, adenoids, defective vision, et cetera. The educator should be quick to avail himself of every advance made in psychology, but these facts must be supplemented by a still broader knowledge of living beings.

The biological conception of education simplifies nomenclature. We have only two conditions to consider: first, that of relatively perfect adjustment of the individual, or health, and defective adaptation, or disease. Incidentally this has a great advantage, as the word insanity at once drops out of use, and the problem of "mental defi-

ciency" to which so much attention is now being directed is correctly valued, becoming merely one phase of the great problem of "unsuccessful life-adjustments."

It would be impossible, within reasonable limits, to discuss all the factors which determine successful or unsuccessful adjustment, and we shall at once dismiss from consideration those commonly designated as hereditary, but we can not refrain from expressing the hope that the discussions upon this important point should not be expressed in terms of such apodictic certitude as to lead a more or less credulous public to believe it is futile to attempt to make the lives of those whose ancestry has not received eugenic sanction happier and more effective.

Successful adjustment in life depends upon the character of the habit-reactions. The formation of good habits predicates the existence of a sound mind and sound body. If an individual does not possess the latter, it is the duty of the educator to give assistance in the effort made to compensate for defective reactions, the result of physical deformities, by compensatory mechanisms. Our sympathy is quickly aroused and we readily give assistance to the cripple who tries to cross a crowded thoroughfare, but how little effort do we take to prevent the tragedies occurring as the result of the encouragement given to the motley throngs driven helter-skelter through schools, colleges and universities, stimulated by false hopes and ambitions to adjust their activities at levels which are sure to precipitate disaster.

A recent writer in the *Atlantic Monthly* has called attention to the enormous waste of time and energy, as well as of money, due to sentimentality. A large part of the present educational curriculum shows plainly the dangers to our national life and the economic loss entailed by the perpetuation of a curriculum in schools and colleges which is an expression of sentiment rather than of reason. Ignorance, as well as pride in our creations have led us to count the successes and to disregard the failures of the system. In round numbers there are 187,000 patients in hospitals for the insane and 183,000 students in colleges and universities. It is known that there are a large number in every community suffering from well-marked psychoses. In the state of New York the estimate has been made that at least 1,800 or 2,000 patients afflicted with alienation should, if provisions existed, be brought under supervision in hospitals.

In other states the proportion of those in need of hospital treatment is greater, so that if adequate provision existed throughout the country the numbers of this army would be increased probably to 250,000. The patients in institutions, as a rule, represent the severe or later stages of imperfect life-adjustments. If we add to this number the list of those suffering from nervous and mental breakdowns in incipient stages, the so-called "failures" in life, and the imperfect adjustments grouped together in the criminal classes, it is evident the successes of our present educational system, as compared with its failures, represent relatively a very small number. In general, we recognize the principle that those are the best guardians of the body in health who have some understanding of the nature of disease. One of the chief aims of the educator should be to assist students in their efforts to become the possessors of sound minds, in sound bodies, and therefore a comprehensive understanding of the biological laws determining human thought and behavior is necessary for every teacher.

Progress in educational, as in all other reforms, is necessarily slow, but the program may be made a practical one from which definite results shall be expected.

1. In the first place it is desirable that the public should be accustomed to the discussion of educational problems in terms adapted to the description of the activities of human beings. With the more general acceptance of the biological view of the subject and the consequent elevation of the teacher from pedagogue to become an adviser and director in all questions relating to the art of living successfully, there would be increased appreciation of the honor and dignity of this profession, and greater possibility of obtaining financial recompense in proportion to the value of service rendered to the community.

2. There should be as rapid an extension as possible of special classes and schools for those whose capacity to adjust at the higher levels of activity is impaired. Provision should also be made, not only for the cases of imperfect intellectual adaptation, but for those in whom the emotional life abnormally dominates reason.

3. The insistence in schools, as well as in the higher institutions of learning, upon the cardinal principle that the acquisition of good habits, and not of information, should be the final test of a successful education. Think of the remarkable gain to our civilization if children were taught fewer subjects, but were given assistance in acquiring good postural habits, were taught to breathe deeply, to speak without a nasal twang, to eat slowly, and were not allowed to imitate the nervous habits of parents or teachers, or to crystallize into permanent form the undesirable reactions induced by fatigue or protracted study in poorly ventilated rooms. Good as well as bad habits are generally cumulative. Training the eye to see, the ear to hear, and the hands to perform the coordinated movements essential in the manual arts will lead to the formation of many of the mental mechanisms characteristic of the man of culture. Greater freedom from prejudice of creed and race, more rapid progress in the search for truth, would result if care were taken in the homes and schools to prevent the formation of those habit-reactions which give an abnormal degree of fixity to ideas and produces a state of mind described as stereophronesis.[3] The prophylactic treatment consists in an avoidance of intense emotional reactions, the cultivation of sense-perceptions, and the capacity to obey the three cardinal impulses essential for genuine temperance reform, "Stop, Look, Listen."

If attention should be placed upon the importance of habit-formation and directed away from futile academic discussion relating to the introduction of this or that variation in the curriculum of study, a great saving of time to students and teachers, and of money to the nation, would be the result. The American university to-day, in certain aspects, suggests a hospital to which students are sent in large numbers with the double purpose of correcting the bad mental habits acquired in homes or schools and of inoculating the undergraduates with the germs of culture.

The task is an impossible one and entails an enormous annual sacrifice of the best brains of the nation. Habits of work and the mental trends leading to the development of intellectual interests are formed during the school period and not later. If students were trained at home and at school to acquire good habits of work, they should pass directly from the high school to real university work, so that much work of the college could be readily eliminated. This change would at once set free the men now in our universities who, under the present archaic system, have become slaves to teach-

[3] This term was suggested by Professor Edward Capps as descriptive of the mechanisms underlying the "idée fixe."

ing, to prosecute research and to add to the store of our knowledge. The present tendency to ruthlessly sacrifice sums of money, as well as the energies of members of a university faculty in performing tasks which should be assigned to teachers in the elementary and primary schools, is a serious menace not only to the intellectual life, but to the mental health of the nation. The absurd pedagogical tasks imposed upon university professors of attempting to give to mature students the mental mechanisms characteristic of men of culture, which should have been acquired either at home or in the kindergarten, represent forms of servitude that should not be tolerated in these institutions.

4. As regards the actual training of teachers competent to approach the study of educational problems from the biological point of view, much can be accomplished by creating in the universities increased facilities for study in this direction.

The establishment of departments of biological psychology, independent of any direct affiliation with those of philosophy, is desirable. At present, philosophy and psychology suffer from the effects of an unnatural union continued merely out of respect for tradition, and a disinclination to do that which is right in the face of adverse criticism.

If the universities intend to become centers for the study of human activities with a view to making life pleasanter and more effective, they should renounce any half-hearted interest in the development of biological psychology as indicative of a lack of intelligent sympathetic appreciation interest in the solution of problems having a vital bearing upon the progress of our civilization. In universities where this division has already been accomplished by which philosophy and psychology have been set free to develop normally, it is to be hoped ample provision will soon be made for the establishment of biological psychology upon a basis indicating that at last human intelligence has awakened to appreciate "the true study of mankind is man."

In addition to the extension of present courses and facilities for training teachers, ample provision should be made for instruction along special lines in our medical schools, as has been suggested by Professor David Spence Hill; particularly in connection with the work in the psychiatric clinics. Instruction in this particular field should be directed to the demonstration of methods for studying the human individual and for giving teachers an opportunity to become familiar with the early symptoms of imperfect adjustment, and the treatment applicable to individual cases.

I have attempted to indicate a few of the essentials of an education when the process is considered as a means of directing the activities of living beings. Education is one of the youngest of all the arts. Its renaissance followed the birth of the biological sciences. Long held in bondage by those afflicted with an hypertrophied historical sense or cultural mysticism, its growth was retarded by man's whimsical and inconstant interest in the study of his own activities. If teachers and students were compelled to walk backwards with their gaze constantly fixed upon the monuments of the past it was no wonder they stumbled and often fell while climbing the mountains. The struggle to become free from the paralyzing influences of tradition and superstition continues, but hopes for progress and for the reduction of human inefficiency, waste and suffering depend primarily for their realization upon the recognition of the general biological principles which actually determine human life and human ideals.

STEWART PATON
PRINCETON, N. J.

ADDRESS BEFORE THE BIOLOGICAL DIVISION OF THE AMERICAN CHEMICAL SOCIETY[1]

GENTLEMEN, I did not come to Rochester with the intention of making a speech, but find—I am sorry to say—that Professor Chambers expects me to talk. He made the request—or, shall I say, demand—as we came into this room. I find that I am driven to the usual refuge of those who have to speak when they would rather be silent—that is, I will take refuge in the history of my subject.

This subject has, I think, some general interest because originally no very definite distinction was made between biochemistry and any other kind of chemistry. One of the first real biochemists was Lavoisier, whom all matter, whether living or dead, interested. He performed the first calorimetric experiments. He was the inventor of the ice calorimeter, and showed that animal heat was the result of oxidation. All the chemists of that generation and the immediately succeeding one did biochemical work. I need only cite Liebig, who is perhaps in some ways the greatest of all biochemists. Unfortunately, about the latter part of Liebig's life chemists lost interest in biochemistry. This was due very largely to the sudden and tremendous development of organic chemistry, which was brought about by the discoveries of men like Hofmann and Kekulé. It was so easy to make new synthetic substances and thereby gain a sort of immortality, even though the main result of putting a chlorine atom here and a bromine atom there was to fill up Beilstein. In consequence, thoroughly trained chemists did not busy themselves with subjects that were really important in the elucidation of that matter which is found in living organisms, and which forms the physiological basis of life. The scientists in biology and medicine needed such information. The chemists did not give it to them. Consequently, physicians and physiologists who were ill-equipped for chemical research were forced to carry forward the work of biochemistry. Though the net result of their work made decidedly for progress, only too often it created confusion and artificial difficulties. Even the best biochemists of those days make us wonder why they did not pursue their chemical investigations as far as the chemical methods of that day would permit. The answer is, I think in many cases, that they were not real chemists but physiologists with a chemical veneer. Fortunately, this has been changing during the past decade, largely owing to the work of Emil Fischer. While we recognize in him a master of chemical technique, we may be certain that in a measure, at any rate, the preeminent position which he occupies among the chemists of his time is due to his clear conception of the really most important work in organic chemistry along biochemical lines. Fortunately, more and more organic chemists are following in his footsteps, and are devoting their attention to substances which occur in living things. I wish here to make a plea for more of this sort of work in America. I believe that the rewards and recognition for knowledge of chemistry applied in biochemistry are great, because the work of the biochemist will be applauded not merely by chemists, but also by zoologists, botanists and physicians. A biochemist has a wider audience because his work presents a more general appeal than the work of organic chemists upon such subjects as dyestuffs and the like. Further, I wish to point out the value of instruction in allied subjects. Not every organic chemist can successfully attack all biochemical problems. Because his organic chemistry, other experience in physiology, and above all, experience in dealing with substances which do not crystallize, are necessary. In many cases it is difficult to conduct biochemical research because the biochemist must very frequently begin with the smears, which the organic chemist consigns preferably to the slop jar. While the things which will not crystallize interest less the organic chemist, they are the very classes of substances with which the biochemist must deal. Great care, great patience and a knowledge of colloids are required of the organic chemist who wishes to work in biochemistry, but I feel

[1] Given by the chairman, Rochester, N. Y., September 12, 1913.

confident that the reward for such men is great, not merely in pure science, but also in industries and in the arts.

The history of biochemistry in America is similar to that abroad. In America it developed first in the seventies and eighties in the medical schools of the country; and, at that time, it was controlled by physicians and physiologists abroad. The subject was narrowed to the consideration of biochemistry as affecting the life of man. That is to say, the chemical side of physiological processes of the human body together with such considerations of bacteriological chemistry as affect man in health and in disease. This phase of biochemistry is cared for very adequately and acceptably by the American Society of Biological Chemists, the first biochemical society to be formed in America.

The phase of biochemistry which the American Chemical Society can very naturally expect to encourage are quite distinct from the aims of the American Society of Biological Chemists. Our usefulness will include the biochemistry affecting agriculture, phytochemistry in particular, and such industrial processes as are based upon biochemical reactions. For example, the more exact study of the chemical composition of fruits, grains and food products. It must be admitted that, at present, we know only those chemical substances occurring in considerable amounts in such important grains as wheat and corn. The minor constituents in grains of much importance have not been identified with exactness. If we consider grains of less importance even this degree of knowledge can not be claimed.

Some of our most important modern industries, like those dealing with starch, artificial fabrics, leather tanning materials, glue and gelatin, meat packing and the flour-milling industry require biochemists, and we are now training men to deal with such practical problems.

If our society confines itself to the activities already mentioned, there still remains a wide field of biochemistry uncared for, the biochemistry of the lower animals. This part of the biochemical work will become a part of the work in the zoological societies of the country. My view is that three societies of biological chemistry can well exist in America without competing in any way and each one caring for a specific need. These would include the biochemistry of the higher animals and its application to medicine; the biochemistry of the lower animals, and biochemistry in its application to plants, agriculture and the industries.

Carl L. Alsberg

MEETING OF THE COMMITTEE ON POLICY OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The committee on policy met at the Cosmos Club, Washington, on November 17, 1913, at 8 P.M., Chairman Minot presiding. Messrs. Fairchild, Nichols, Humphreys, Cattell and Howard were also present.

The permanent secretary made an ad interim report of progress, stating that, unexpectedly, news from the Pacific Coast Division had been delayed by reason of floods and that his office was not definitely informed of action taken by that committee. He stated that the committee having power to appoint the temporary secretary for the South had selected Dr. Robert M. Odgen, of the University of Tennessee, and that he had been actively engaged in the work since October 1, and a letter which he sent out to southern members was read. The report on membership showed a satisfactory increase. With regard to the Atlanta meeting, the permanent secretary stated that, owing to delay upon the part of the Atlanta local committee, the preliminary announcement was not yet in type but that he expected to be ready to mail it before the end of the month.

The arrangements for the Atlanta meeting were discussed and it was decided to have two evening lectures, complimentary to the citizens of Atlanta, one by Dr. C. W. Stiles, of the Public Health Service, on the Health of the Mother in the South, and one by Professor Charles E. Munroe, of the George Washington

University, on Explosives Made and Used in the South during the Civil War. It was decided to hold the retiring presidential address on Monday night, December 29.

A discussion as to the future meetings of the association was taken up and, on motion, it was resolved to recommend to the next general committee that Toronto be selected for the convocation week meeting of 1915–1916.

It was resolved that efforts be made to hold large representative convocation week meetings at four-year intervals, the first to be held in New York in 1916–1917 and the second in Chicago in 1920–1921.

The permanent secretary was ordered to report to the affiliated societies that the committee on policy has under consideration the advisability of meeting in 1917–1918 at Columbus, Urbana or Cincinnati, in 1918–1919 at Boston, and in 1919–1920 at St. Louis or Nashville.

On motion, the permanent secretary was instructed to inform the affiliated societies that the committee on policy has recommended that efforts be made to hold large convocation week meetings in New York in 1916–1917 and in Chicago in 1920–1921, and to inform the affiliated societies that he has been instructed to forward this information that the societies may plan accordingly.

On motion, the committee on organization and membership was authorized to examine into the desirability and feasibility of organizing local branches of the association.

On motion, it was resolved that the treasurer, in making re-investment of $20,000 of the permanent funds of the association under the authority of the resolution of the council of December 30, 1911, be authorized by the committee on policy to invest in the best interest-bearing securities permitted by the Massachusetts laws regulating the investment of trust funds and, further, in order to simplify the approval of the committee on policy, as provided for in the resolution, it was resolved that Messrs. Humphreys and Howard be appointed a sub-committee with power to act in approval for the committee on policy on the investments selected by the treasurer and to assist him in making the selections.

THE NEW YORK STATE MUSEUM

The New York State Museum has recently acquired by gift and purchase a noteworthy series of collections representing the Iroquois and pre-Iroquois cultural relics from within the state. The O. C. Auringer collection from northeastern New York is especially interesting for its many ancient relics of Eskimauian type and early Algonkian occupation. These are principally from Glen Lake, Saratoga county.

The Raymond G. Dann collection is almost entirely from the historic Seneca village of Totiacton, in Monroe county. It is an interesting illustration of the articles used at the early contact period. Clay vessels and copper pots were found side by side together with very elaborate articles in bone and shell.

The R. D. Loveland and Charles P. Oatman collections from Jefferson county comprise extraordinary series of clay and stone pipes, and a large variety of bone implements and polished stone ceremonials. The collections contain objects from the Eskimauian and early Algonkian cultures, and of equal if not greater interest is the fine series illustrating the culture of the early Onondaga-Iroquois.

The Frederick H. Crofoot collection is from the Genesee valley and represents the various occupations of the middle portion of the valley. Many crude objects show an early and transient occupation, but in the collection are some remarkable specimens from the Iroquois and from the earlier mound-building people.

The Alva S. Reed collection, brought together from a site near Richmond Mills, Ontario county, represents the culture of a prehistoric Seneca village, one of the few found in that region.

The extensive series brought together by Professor Dwinel F. Thompson, of the Rensselaer Polytechnic Institute, is a typical assemblage of the cultural relics of the upper waters of the Hudson. It contains many valuable

specimens also from the lower Mohawk, including pipes and earthy vessels.

Other acquisitions in archeology and ethnology are under present consideration by the Museum, the plan being to illustrate as fully as practicable the aboriginal history of New York, the culture of the Iroquois and the peoples who preceded them.

The Museum has also acquired the very unusual collection of minerals from Orange county, N. Y., made by the late Silas A. Young from localities which are, for the most part, no longer productive; and also the last of the great collections of paleozoic fossils brought together by the Gebhard family through three generations from the classic Schoharie valley, a region which might appropriately be called the cradle of American stratigraphy.

SCIENTIFIC NOTES AND NEWS

THE Hughes medal has been awarded by the Royal Society to Dr. Alexander Graham Bell.

DR. AUBREY STRAHAN has been appointed director of the British Geological Survey and Museum in succession to Dr. J. J. H. Teall, who will retire on January 5.

PROVOST EDGAR F. SMITH, of the University of Pennsylvania, has been elected a member of the board of trustees of the Carnegie Foundation for the Advancement of Teaching to succeed Dr. Ira Remsen, recently president of the Johns Hopkins University.

RECENTLY a movement was set on foot for the presentation to the Royal Society of a portrait of Dr. Alfred Russel Wallace, to be painted by Mr. J. Seymour Lucas, R.A. Professor Raphael Meldola, 6 Brunswick-square, W.C., and Professor E. B. Poulton, Wykeham House, Oxford, had undertaken to receive subscriptions. The proposal will not be abandoned in consequence of Dr. Wallace's death, though it will be necessary to have a posthumous portrait painted from a photograph.

THE following is a list of those who have been recommended by the council of the Royal Society for election into the council at the anniversary meeting on December 1: *President*—Sir William Crookes; *Treasurer*—Sir Alfred Kempe; *Secretaries*—Sir John Bradford and Professor Arthur Schuster; *Foreign Secretary*—Dukinfield Henry Scott; Other members of the council—The Right Hon. Arthur James Balfour, Professor William Maddock Bayliss, Frank Watson Dyson, Henry J. H. Fenton, Professor William Gowland, Frederick Gowland Hopkins, Sir Joseph Larmor, Professor Charles H. Lees, Professor Ernest William MacBride, Professor Grafton Elliot Smith, Professor James Lorrain Smith, Sir John Thornycroft, Professor William Whitehead Watts, Alfred North Whitehead, Charles T. R. Wilson and Arthur Smith Woodward.

DR. FILIPPI is to lead an Italian expedition to the Himalayas next summer. The explorer intends to spend the present autumn in Chinese Turkestan, carry on observations into Russian Turkestan, winter in Scardo in Baltistan, and early next spring travel to Leh by the inner Indus valley. From Leh the expedition will travel to the Karakoram to survey and map the unknown portion of the range between the Karakoram Pass and the Siachen glacier. The Government of India has subscribed £1,000 to the funds, and Major Woods of the Trigonometrical Survey will accompany the expedition.

MR. F. T. BROOKS, of Emmanuel College, Cambridge, is leaving England for the Federated Malay States in order to report to the government on fungoid diseases and whether anything can be done to arrest them. Mr. Brooks has received one year's leave of absence from the university.

PROFESSOR JOSEPHINE TILDEN, of the department of botany, University of Minnesota, has returned from Australia and New Zealand, where she spent the past year in botanical research in the field and in collecting material in algology.

THE fourth lecture before the Harvey Society will be given at the New York Academy of Medicine, on Saturday evening, November 29, by Professor G. H. Parker, of Harvard University, on "The Nervous System, its Origin and Evolution."

PROFESSOR ELLSWORTH HUNTINGTON, of Yale University, delivered an illustrated lecture on "Changes of Climate during Historical Times," on November 3, before the New York Academy of Sciences, at the American Museum of Natural History.

PROFESSOR SHEPHERD IVORY FRANZ, scientific director and psychologist of the Government Hospital for the Insane, Washington, D. C., on November 15 addressed the Medical Society of St. Louis, on the subject of "Psychological Factors in Medical Practise."

REINHARD A. WETZEL was the guest of the research department of the General Electric Company, at Schenectady, on November 8. The subject of his address before the colloquium was "Einstein's Relativity Concepts as Interpreted by a Physical Model."

FOUR lectures on the "Aspects of Islamism" will be delivered at the University of Chicago near the end of the winter quarter by the professor of Arabic at the University of Leiden, Dr. Christian Snoucke Hurgronje.

A MEETING of the Pathological Society of Philadelphia was held on Thursday evening, November 20, at the College of Physicians, when there was a symposium on the subject of "Physical Growth and Mental Development." The speakers were as follows: Dr. H. H. Donaldson, of the Wistar Institute, "Studies on the Growth of the Central Nervous System"; Professor Bird T. Baldwin, of Swarthmore College, "The Normal Child; Its Physical Growth and Mental Development"; Professor Lightner Witmer, of the University of Pennsylvania, "Children with Mental Defects Distinguished from Mentally Defective Children." The discussion was opened by Professor James H. Leuba, of Bryn Mawr College, Dr. H. H. Goddard, of New Jersey Training School, Vineland, N. J., and Dr. Charles W. Burr, of Philadelphia.

THE Hermann Knapp Memorial Eye Hospital has opened its new building at the corner of Fifty-seventh Street and Tenth Avenue, New York. It was founded in 1869 by the late Dr. Hermann Knapp under the name of the New York Ophthalmic and Aural Institute, and for forty-four years it has been in uninterrupted activity at 44 and 46 East Twelfth Street. On the occasion of its removal to a new building in a new location, the board of trustees decided to change the name of the institution in honor of its founder. The new building is seven stories in height, fireproof throughout, and is equipped with all modern appliances for the treatment and study of diseases of the eye.

THE trustees of the American Medical Association have made a new appropriation for the Committee on Scientific Research. The committee has decided to use this money as far as possible to promote work in medical research where suitable conditions exist but where such work suffers for the lack of relatively small sums of money. Applications for grants are invited and may be sent to any member of the committee which consists of L. Hektoen, 1743 W. Harrison Street, Chicago; S. Flexner, Rockefeller Institute for Medical Research, New York, and Wm. Litterer, Vanderbilt University, Nashville, Tenn.

THE surgeon general of the army announces that preliminary examinations for appointment of first lieutenants in the Army Medical Corps will be held on January 19, 1914. Full information concerning these examinations can be procured upon application to the "Surgeon General. U. S. Army, Washington, D. C." The essential requirements to secure an invitation are that the applicant shall be a citizen of the United States, shall be between 22 and 30 years of age, a graduate of a medical school legally authorized to confer the degree of doctor of medicine, shall be of good moral character and habits, and shall have had at least one year's hospital training as an interne, after graduation. The examinations will be held simultaneously throughout the country at points where boards can be con-

vened. Due consideration will be given to localities from which applications are received, in order to lessen the traveling expenses of applicants as much as possible. In order to perfect all necessary arrangements for the examinations, applications must be completed and in possession of the adjutant general at least three weeks before the date of examination. Early attention is therefore enjoined upon all intending applicants. There are at present twenty-six vacancies in the medical corps of the army.

By invitation of the Comité des Forges de France, the autumn meeting next year of the British Iron and Steel Institute will be held in Paris, the dates of Friday and Saturday, September 18 and 19, having been provisionally fixed for the business sessions. The first half of the following week will be devoted to excursions to the chief iron-mining and manufacturing districts of France.

On November 24 the Portland Society of Natural History held a public meeting devoted to an informal observance of the seventieth anniversary of the day of its founding. The principal feature of the meeting was a historical address by the recording secretary, Major John M. Gould. Mr. Gould's term of life accords almost exactly with that of the existence of the society and its museum. He was a constant and interested visitor at the museum through his childhood and youth. In early manhood he became officially connected with the organization and has been actively connected with it to the present time. The society was founded during that period which brought forth numerous organizations of a similar nature, when Maine was a young state, recovering from the disadvantages of having long been a hostile frontier. In the outskirts of population, the society has lived through years of activity, and periods of adversity, twice having had its museum and its contents swept out of existence by fire. It still stands, true to the objects of its founders, "for the promotion of the study of natural history," with a substantial building for its museum and library.

Dr. J. M. G. Carter, of Los Angeles, Cal., has given his medical library and part of his scientific library to the University of Southern California.

Professor Julius Hann, the eminent climatologist of Vienna, wishes to find a purchaser for his meteorological library which has accumulated on his hands far beyond his power to take care of it properly. Owing to the fact that he has to live on a pension, since he was retired from active government service and is obliged to live in small quarters, the greater part of his library is already packed away in boxes. His great collection of books and separates will be a fine addition to the library of any institution that desires to complete its collection of books bearing on meteorology and climatology.

Professor Ernst Haeckel has written from Jena under the date of October 12, 1913, the following letter:

To My Friends, Pupils and Disciples:

I have from several sides been informed that a number of my friends, pupils and disciples intend to celebrate my eightieth birthday on the sixteenth of February, 1914, by presenting me with gifts about the form and nature of which different proposals have been made. Having repeatedly been honored on former occasions by such gifts, I beg *to abstain this time from all personal donations*, and to convey the amount of the means, destined for this purpose, to a foundation, which I should be glad to put to the disposal of the German Monists' Union. The wonderful development, which this modern union of culture has attained since its foundation seven years ago, the high importance which it has acquired for the promotion of a free and rational conception of life as well as for its practical application to a conduct of life of superior morals render its financial support by ampler means most desirable. The intended new "Ernst-Haeckel-Fund for Monism" shall incessantly further this work of culture of the free thought on the positive basis of natural science and furnish the necessary means to carry practically on its numerous important tasks. I anticipate my heartiest thanks to all my friends and comrades, who, by participation, will support the work of my long life.

On the first International Monists' Congress, which took place in September, 1911, in Ham-

burg, and which was such a splendid success, also because foreign countries took so numerously part in it—it became the principal aim to extend the German Monists' Union, and to make it an International Union. This Universal Monists' Union, representing an immense promotion of our high tasks of culture by uniting the free-thinkers of all countries, will be the more able to prove its importance practically, the more liberal also my friends abroad in all the continents will partake of the gifts for the new foundation.

The new seven and one half-inch photographic telescope was placed in position in the Memorial Observatory of the Nantucket Maria Mitchell Association on November 15, the mounting and final adjustment by Alvan Clark and Son's Corporation, completing the work. The lens was made by T. Cooke & Sons, York, England. It has been subjected to various tests at Harvard College Observatory by the director, Dr. Edward C. Pickering, personally, and by his several assistants who have given it careful attention. Rev. Joel H. Metcalf, whose astronomical discoveries by means of photographs are well known, has also carefully examined its work. By all of these it is pronounced good. The Nantucket Observatory is now well equipped for photographic study of asteroids or other heavenly bodies.

The London Astronomical Society opened on November 7 at Alton, Hants, a new observatory erected by one of its members, Mr. James H. Worthington. The site selected is over 600 feet above sea level, near the Melstead Station. Here Mr. Worthington has erected what, both in finish of instruments and in general facilities, is said to be the finest private observatory in England. It is more than 20 miles from any manufacturing town, and the atmosphere is not affected by any strong artificial lighting. There are altogether six telescopes. The two largest are under domes 24 feet and 22 feet in diameter, respectively, and are a 20 inch reflector and a 10 inch refractor.

Statistics of the fertilizer industry in the United States for 1909 are presented in detail in a bulletin soon to be issued by the Bureau of the Census. It was prepared under the direction of W. M. Steuart, chief statistician for manufactures. The report covers establishments making artificial fertilizers, the products being ordinarily ready for use without being subjected to further treatment. The production of certain kinds of products which are used more or less exclusively for fertilizing without further manufacture is not covered by this report. The raw materials used by fertilizer factories include animal, vegetable and mineral products, while sulphuric and other acids are employed extensively in the treatment of the basic materials. The finished products include a variety of classes, such as "complete" fertilizers, which consist of a mixture of superphosphates with both potash and ammoniates, superphosphates with or without ammoniates, concentrated phosphates, and other minor classes. The total number of establishments reported as engaged primarily in the manufacture of fertilizers in 1909 was 550, with a capital of $121,537,451. The number of persons engaged in the industry was 21,950, of whom 18,310 were wage earners. The total value of all products of the 550 establishments amounted to $103,960,213, of which $92,369,631 was the value of fertilizers proper, the amount of which was 5,240,164 tons. The sum of $11,882,815 was paid out for services, of which $7,477,179 was for wages. As judged by the amount expended for them, ammoniates, animal and vegetable, were the most important materials, followed by phosphate rock, potash salts, superphosphates, nitrate of soda, ammonium sulphates, sulphuric acid, fish, pyrites, and kainit in the order named. The cost of materials aggregated $55,360,423 in 1909, $28,975,713 in 1904, and $23,454,126 in 1899. Of these respective totals, the cost of ammoniates formed 42.4 per cent. in 1899 as compared with 34.2 per cent. in 1904 and 29 per cent. in 1909. The cost of phosphate rock shows only slight proportionate changes; it constituted 15.2 per cent. of the total of the specific materials in 1899, 14.6 per cent. in 1904, and 15.6 per cent. in 1909. The cost of potash salts represented 13.2 per cent., 12.4 per cent. and 13.2 per cent. of the total for the

respective years; and the aggregate cost of sulphuric acid and pyrites and sulphur constituted 13.2 per cent. of the total in 1899, 11 per cent. in 1904, and 11.2 per cent. in 1909. All fertilizer establishments manufacturing sulphuric acid employed the chamber process, sixteen using the Hoffman intensifier system, eleven the Pratt, nine the Gilchrist, three the Meyer tangential system, and one the Luney. The manufacture, for consumption in their own works, of 1,826,358 tons of acid phosphate was reported by establishments engaged primarily in the fertilizer industry, and 12,507 tons were made and consumed by establishments manufacturing fertilizers as a subsidiary product.

All records have been broken in the great mineral production of the United States for the year 1912. The year 1907 has heretofore been the banner year of American mineral output, with a total value of $2,072,666,639, but even this great figure was exceeded in 1912 by over $170,000,000. As compared with 1911, the increase in 1912 is $316,098,198, or 16.40 per cent. These figures are shown in a summary of the mineral production of the United States for 1912, compiled by W. T. Thom, of the United States Geological Survey, now in press. As heretofore, iron and coal are the most important of our mineral products. The value of iron (pig iron being the basis of valuation) in 1912 was $420,563,388; the value of coal was $695,606,071. The value of the fuels—coal, natural gas and petroleum—increased from $835,231,497 in 1911 to $943,972,362 in 1912, a gain of $108,740,865. Coal showed an increase in value of $60,040,860, from $626,565,211 in 1911 to $695,606,071 in 1912. The production of metals increased in value $186,571,303, from $680,531,782 in 1911 to $867,103,085 in 1912. The nonmetals increased $129,276,895, from $1,246,750,346 in 1911 to $1,376,027,241 in 1912. The unspecified products, including cadmium, selenium, rutile, uranium, vanadium and other minerals, valued at $500,000, increased $250,000, bringing the total value of the mineral production for 1912 up to $2,243,630,326. The production of pig iron in 1912 gained more than $93,000,000, or 28 per cent.; ferro-alloys gained nearly $4,000,000, or about 46 per cent.; silver gained more than $6,000,000, or 20 per cent.; copper gained about $68,000,000, or nearly 50 per cent.; zinc gained nearly $14,000,000, or 44 per cent., and aluminum gained nearly $4,000,000, or 47 per cent. Gold, which lost about $3,500,000, was the only important metal to show a decrease. Among the nonmetals bituminous coal gained approximately $67,000,000, or about 15 per cent.; anthracite coal gained more than $2,000,000; natural gas gained almost $10,000,000, or 13 per cent.; petroleum gained nearly $30,000,000, or 22 per cent.; clay products gained more than $10,000,000, or 6.5 per cent., and sulphuric acid from copper and zinc smelters (a product mined as it were out of the air and changed from a destructive waste to an absolute gain) increased $1,500,000, or 55 per cent.

UNIVERSITY AND EDUCATIONAL NEWS

An anonymous gift of $100,000 has been made to Wellesley College. The money was given towards the million-dollar fund which the college is trying to raise as an endowment. The total amount obtained thus far is $453,000.

Yale University has received a gift of $50,000 from Mr. Charles H. Pine, of Ansonia, Conn., to be used for scholarships under terms to be announced later.

Dr. Francis Gray Smart, of Tunbridge Wells, has left £10,000 to Gonville and Caius College, Cambridge, for two "Frank Smart Studentships" in natural history or botany, and if this sum shall be more than sufficient to provide for these studentships the balance is to be used to promote the study of these subjects in that college.

Mr. Otto Beit has given £2,000 to Cambridge University for a library of German books, together with £1,000, of which the income is to be devoted to additions.

The certificated teachers of Herefordshire have decided to take action in a body with a view to compelling the education authority to redress the grievances from which they allege

they suffer. The first group of about 100 resignations has been sent in to terminate on January 31, 1914, these being resignations of headmasters and headmistresses only. For various reasons the remainder of the resignations are being delayed for consideration by the executive of the National Union of Teachers.

AT the University of Chicago, Elbert Clark has been appointed instructor in anatomy, and Cora C. Colburn, instructor in home economics.

MR. J. H. MUNCIE, assistant pathologist at the Ohio Agricultural Experiment Station at Wooster, Ohio, has been appointed assistant in plant pathology at the Michigan Agricultural College, beginning with November 17.

AT the Worcester Polytechnic Institute Assistant Professors D. L. Gallup and Frederic Bonnet, Jr., have been advanced to full professorships in gas engineering and chemistry, respectively. Dr. D. F. Calhane, instructor in industrial and electro-chemistry, has been appointed assistant professor in his department. P. W. Brouwers, '13, returns to the institute as instructor in mathematics, and G. S. Simpson, who graduated from the University of Maine last June, becomes assistant in chemistry, replacing E. B. Peck, who has taken up a course of graduate work at the Massachusetts Institute of Technology.

THE University of Minnesota added to its scientific faculties, this year, the following new members: Dr. E. P. Lyon as dean of the College of Medicine; as professors: Frederick J. Alway in agriculture, Josephine T. Berry in home economics, Arthur D. Hirschfelder in medicine, C. M. Jackson in medicine, F. M. Mann in architectural engineering, Adolph F. Meyer in engineering, Roscoe W. Thatcher in agriculture, George T. Young in mining, and T. B. Hutcheson in agriculture; as assistant professors: Alva Hartley Benton in agriculture, W. H. Brierly in agriculture, Robert O. Dahlberg in agriculture, R. L. Donovan in agriculture, Robert A. Hall in medicine. Estelle L. Jensen in agriculture, Francis Jager in agriculture, R. S. Mackintosh in agriculture, T. B. McCulloch in agriculture, Peter J. Olson in agriculture, C. C. Palmar in agriculture, C. J. Posey in geology, Richard Wellington in agriculture and George A. Works in agriculture; as instructors: George D. Allen in animal biology, W. O. Beal in astronomy, E. C. Davis in agriculture, R. Dietrichson in chemistry, John T. E. Dinwoodie in agriculture, Albert M. Gilbertson in anthropology, Julian H. Gist in agriculture, Alex. R. Hall in medicine, Arthur T. Henrici in medicine, R. C. Jones in engineering, F. B. Kingsbury in medicine, W. Kritchevsky in chemistry, H. J. Leonard in dentistry, Mabel McDowell in agriculture, W. L. Miser in mathematics, Agnes Morton in agriculture, D. O. Ostergren in dentistry, Rollin M. Pease in agriculture, R. M. Peterson in agriculture, E. R. Pinney in dentistry, A. C. Potter in medicine, C. H. Rogers in pharmacy, C. O. Rost in agriculture, H. C. Samuels in dentistry, J. F. Shellman in dentistry, E. K. Strachan in chemistry, H. M. Sheffer in psychology, Frank Smithey in medicine, Mabel Barbara Trilling in agriculture, Grace T. Williams in agriculture, Robert Wilson in agriculture and J. J. Willaman in agriculture.

DURING the past year the following appointments have been made for persons who have graduated at the University of Illinois or who have been there within two years as graduate students in chemistry.

J. E. Bell, instructor in chemistry, University of Washington, Seattle, Wash.

R. A. Dutcher, instructor in agricultural chemistry, Agriculture College, Corvallis, Oregon.

J. E. Egan, assistant professor of chemistry, Miami University, Oxford, Ohio.

H. B. Gordon, assistant professor, Agricultural and Mechanical College of Texas, College Station, Texas.

L. R. Littleton, professor of chemistry, Emory and Henry College, Emory, Virginia.

W. S. Long, assistant professor of chemistry, in charge of the food laboratory, Lawrence, Kansas.

C. Ferdinand Nelson, assistant professor of physiological chemistry, University of Kansas, Lawrence, Kansas.

L. F. Nickell, instructor in chemistry, Washington University, St. Louis, Missouri.

H. L. Olin, instructor in chemistry, Vassar College, Poughkeepsie, N. Y.

R. S. Potter, research assistant, Agricultural Experiment Station, Iowa State College, Ames, Iowa.

E. K. Strachan, instructor in chemistry, University of Minnesota, Minneapolis, Minn.

G. Y. Williams, associate professor of chemistry and acting head of the chemistry department in the State University of Oklahoma, Norman, Oklahoma.

P. S. Woodward, instructor, Georgia School of Technology, Atlanta, Georgia.

THE electors to the Waynflete professorship of physiology at Oxford, vacant by the death of Dr. Francis Gotch, have elected Dr. Charles Scott Sherrington. Dr. Sherrington succeeded Dr. Gotch as Holt professor of physiology at the University of Liverpool in 1895, when Dr. Gotch was called to Oxford.

DISCUSSION AND CORRESPONDENCE

MATHEMATICAL DEFINITIONS IN THE NEW STANDARD DICTIONARY

FUNK and Wagnalls's "New Standard Dictionary of the English Language," 1913, has many merits and will doubtless be used very extensively. It is, therefore, of special importance to direct public attention to the fact that this dictionary is not reliable as regards definitions of mathematical terms. Some of these definitions will doubtless interest even those who remember only a little of their mathematics, as they relate to elementary matters and are so evidently incorrect. The following list of examples could easily have been extended, but it is believed that it will not require many examples of this type to convince the reader.

Under the term *algebra* it is stated that the infinitesimal calculus and the theory of functions may be classed among "the principal branches of algebra." A hundred years ago such a statement might have appeared proper, but it is not in accord with any of the classifications which have been extensively adopted in recent years, such as those employed in the International Catalogue of Scientific Literature and in the large mathematical encyclopedias which are in the course of publication. In fact, the infinitesimal calculus and the theory of functions are generally regarded as branches of analysis.

The explanations which follow the term *arithmetic* include the statement that the early Pythagoreans first studied arithmetic. On the contrary, it is well known that the ancient Babylonians and Egyptians made considerable use of elementary arithmetic, as may be seen from the extensive mathematical tables of the ancient Babylonians and the large collection of examples by the Egyptian scribe Ahmes. Possibly the early Pythagoreans might be regarded as the first workers in higher arithmetic or the theory of numbers.

An instance of a statement which is more evidently incorrect appears under the term *dimension*. It is here stated that four-dimensional space may be regarded as a hypothetical conception to explain equations of the fourth degree in analytical geometry. As a matter of fact an equation of any degree in two variables may be represented geometrically in the plane. It is the number of the variables and not the *degree* of an equation which corresponds to the number of dimensions required for its representation.

Under the term *equation* it is stated that an abelian equation is an equation "all of whose roots are rational functions of one or more of the roots." It is well known that the roots of non-abelian equations may also be rational functions of each other. In an abelian equation we must have the additional condition that its group is commutative.

A fractional function is defined, under the term *function*, as one whose variable appears only in its denominator; and a *Galois resolvent* is said to be "that resolvent of an equation whose roots remain the same when the group of the equation is permuted in any way whatever." It would be interesting to know something about the new theory of permuting the group of an equation. Unfortunately there seems to be no clue in this dictionary as regards the possible meaning of this term.

The most original definitions seem to appear under the term *group*. A complete group is defined as one in which no self-conjugate operations are possible besides the iden-

tity. According to this definition every alternating group whose degree exceeds 3 is complete, while none of these groups is complete according to the definitions of this term given elsewhere. A still more original and more mysterious definition under this term relates to the regular group. It is stated that this is "a transitive group whose order is the same as that of the letter on which it is made."

It is very difficult to see how any one can discover any meaning whatever in such a definition. To make a group on a letter is a process which seems to have been foreign to the literature of this subject. A large number of almost equally vague statements occur under other terms. For instance, under the term *number* it is stated that an irrational number is "a definite number not expressible in a definite number of digits," and a congruence group is defined as a group made up of replacements.

It may probably be assumed that all mathematicians who read these few citations will agree that American mathematicians have good reason to protest against such a butchery of their subject in a popular work of reference. Those who desire more evidence can easily obtain it by consulting this dictionary for the definitions of the following terms: analogy, angle—especially angle of elevation and angle of depression, automorphic, fraction, matrix, mathematical and variable.

G. A. MILLER
UNIVERSITY OF ILLINOIS

A REPLY TO DR. HERON'S STRICTURES

THE all-too-familiar "blessings" of Professor Karl Pearson upon "Mendelians" have recently been continued by his understudy, Dr. David Heron, and directed toward American work in eugenics in general and that of the undersigned in particular. Like my colleagues in this country I should have remained silent under the attacks, knowing that discriminating men of science in this country as well as in England recognize their true animus and that they lie outside the pale of science. But the notoriety given in a daily paper to the publication of Heron and to a "defence" based upon an interview with me by a reporter of the paper lead me to make a brief reply.

I shall not attempt now to answer all the scores of trivial points of criticism made by Dr. Heron, but shall consider only the paper on heredity of epilepsy by Dr. David F. Weeks and myself, which he singles out for special attack. The numerous "errors" to which he calls attention fall for the most part into three categories, based on misunderstanding so gross on the critic's part as to render it difficult to believe that they are not intentional. First, Dr. Heron seems to assume that whenever a symbol in a pedigree chart is not accompanied on the chart by some special description it stands for a person about whom nothing is known. He calls attention to numerous cases where, notwithstanding, the corresponding individual is described in the text. The assumption is a gross error. The chart shows mainly the interrelationship of individuals and indicates only certain traits. Second, Dr. Heron catalogues, with infinite pains, "errors" in citing the case number. Here he has fallen into a trap which the authors unconsciously prepared for him. To avoid the possibility that a person who is not authorized should connect an individual at the institution with his family history it was decided to apply alterations to the case numbers which enable the authors, but not the ordinary reader, to identify the case. None of the "errors" are such as would prevent the use of the numbers by the authors and they could be of no scientific use to others. Dr. Heron used them merely for criticism. Had we anticipated that there was anywhere a man of science with such abundant leisure, we should have published a warning that the reference numbers were for the sake of identification by the authors and not for scientific study. Third, in our tables we analyzed the traits of the "children" into ten columns, but condensed those of the father's sibs, etc., into 5 columns to save space; in some cases father and father's sibs, etc., appear as "children" and the classification is accordingly expanded from 5 to 10 categories. This, of course, is obvious to any intelligent

reader; but it serves our critic to swell the accumulation of details for his contention that our work is careless because the same fraternity is described by the use of different words in different parts of the paper.

A critic who is guilty of such extensive stupid, captious and misleading criticism can hardly expect a scientific consideration of other points he raises of a more general sort. I fear it will be futile for a biologist to attempt to show to the "applied statistician" his errors. Genuine, scientific criticism has always been useful in the advancement of science, but friends of Galton must regard it as a tragedy that the fortune of one of the largest-minded and most fertile-minded men of science should be supporting a laboratory one of whose leading members spends much time making elaborate researches into his delusions concerning the blunders of others instead of making positive discoveries in a field where so little is known and where the need of utilizable knowledge is so great.

Chas. B. Davenport

Cold Spring Harbor, N. Y.,
November 10, 1913

SCIENTIFIC BOOKS

Mineral Deposits. By Waldemar Lindgren. New York, McGraw-Hill Co. Pp. v + 883, Figs. 257. 8vo. $5.00.

In the preparation of this invaluable treatise a great boon has been conferred by Professor Lindgren upon all geologists. The work is of interest not alone to those immediately engaged in mining, but to all who are concerned with the processes of mineral solution and deposition in the earth's crust. For those who have not followed from year to year the advances of observation and interpretation, many new and striking results will appear.

The author has brought exceptional preparation and experience to the task. An old Freiberger, he was grounded by one of the best of teachers, the late Professor A. W. Stelzner, in the "*Lehre*" or "lore" of ore-deposits, and learned of the applications of geology in the steadying atmosphere of an engineering school. Beginning in 1883 on the Transcontinental Survey of the Northern Pacific railroad, Mr. Lindgren entered the U. S. Geological Survey the next year, and has thus had nearly thirty years of study in the mining districts of America. Journeys in Australia and Europe have further amplified experience, and courses of instruction given by him at Stanford University and in the Massachusetts Institute of Technology have served to systematize and formulate conclusions. To all has been added a thorough scholarship and spirit of fairness, such that the resulting work is marked by all these characteristics. It is also the ripe fruition of a little school of American observers, whose views have found special expression in the magazine *Economic Geology*.

The book is divisible into two parts. An introductory one of about one fifth the total embraces the general chemical and structural principles on which the remainder is based. The major portion is thus devoted to a review and discussion of the types of mineral deposits whose scheme of classification is at once the climax of the first part and the skeleton of the second. As the title implies, the work takes up "mineral deposits" rather than "ore deposits." The title makes logical and consistent the treatment both of the deposits with the distinctive metals and those with non-metals. It enables the author to have freer scope in that questions of profitable working are less involved. The title is a little over-inclusive for the subject-matter, because coal, our most important mineral deposit, is not mentioned, although a place for it is provided in the scheme of classification. Old associations were probably so strong with our author that coal, petroleum and natural gas faded from the field of view when actually writing.

In the introduction, water necessarily plays a very important part. Six extremely interesting chapters are devoted to it. For the greater number of mineral deposits water is quite correctly regarded as the all-important agent. Its composition, circulation, chemical reactions and amount are all reviewed. The question, may, however, be raised, whether, when the general shallow penetration of the meteoric

groundwaters into the crust of the earth is appreciated; when the great restrictions upon their actual amount which have been demonstrated in recent years are grasped in their full significance; and when the great depths to which many veins extend are kept before us; we may justifiably state, as on page 24: "However important these (*i. e.*, magmatic waters) may be in the formation of certain kinds of ore deposits, they are insignificant in quantity compared to the great circulation of atmospheric water." It sometimes seems to the reviewer that even while stating newer facts almost from force of habit we are inclined to reiterate older doctrines from beneath which the newer facts have largely removed the foundations. Had we known at the outset of the limited vertical distribution of the meteoric groundwaters and of their small amount, it is quite possible that we should have had a less firmly rooted faith in them as the *prima facie* source of deep-seated circulations, and would have given other kinds of water greater relative importance. The subject is, however, young, and a gradual modification of views may come in time as we escape the hypnotic influence of the past. Indeed, as we read Professor Lindgren's subsequent pages, and especially Chapter VI., we feel as if, when the actual phenomena were reviewed, the magmatic waters seemed of greater and greater importance. Indeed, who can affirm that the surface waters were not themselves once magmatic?

The introductory portion also contains valuable chapters on faults, folds, openings in rocks, textures of deposits and ore-shoots, on almost all of which Professor Lindgren has previously written in a most illuminating way. The classification of mineral deposits, which is to form the framework of the later pages, is introduced by a condensed review of other schemes and of agents.

The scheme of classification is the foundation of the treatise. It is fundamentally based on mechanical processes of concentration on the one side, and chemical, on the other. While these two have been emphasized in one way and another by earlier writers, no one else has so logically and completely carried out the chemical processes in determining the subgroups on the basis of temperature and pressure. The types of mineral deposits are, therefore, taken up in order, beginning with reactions at the surface at ordinary temperatures and pressures, passing to those in the rocks at greater and greater depths and terminating in the natural climax of those produced by processes of differentiation in magmas. Perhaps the question will arise in the minds of some, as to whether we are sufficiently well-informed regarding the temperatures and pressures at which minerals develop in order to make this grouping sound. The reply may be made, that the associations of minerals in the various types are in contrast; that we have learned much from their artificial production; and that the peculiar etch-figures afforded by quartz, a mineral of wide occurrence, and differing according to its crystallization above or below its conversion point of 575° C., have all given critical data now of great significance.

Professor Lindgren reviews practically all the famous mining districts of the world and in connection with them discusses with fullness and illuminating insight the questions of secondary enrichment, of persistence of mineral characters with depth, of contact zones, of magmatic segregations and of pegmatites. Indeed, no student of the subject can read these pages without feeling his interest quickened and his grasp of the causes which have led to the formation of mineral deposits greatly broadened. Professor Lindgren has, therefore, as stated in the opening sentence of this review, placed his colleagues and students everywhere under a great debt by the preparation of a masterly work.

J. F. KEMP

Der Mensch der Vorzeit. Von DR. HUGO OBERMAIER, Professor am internationalen "Institut de Paléontologie Humain," Paris. Mit 39 Tafeln, 12 Karten und 395 Textabbildungen. Allegemeine Verlags-gesellschaft, M. B. H., Berlin, München, Wien. 1912.

"Der Mensch der Vorzeit" very appropriately constitutes Volume I of a monumental work in three volumes[1] entitled "Der Mensch aller Zeiten Natur and Kultur der Völker der Erde."

By way of introduction the author gives a résumé of ancient cosmogony and archeology as seen through medieval eyes, and the founding of geology, paleontology and prehistoric archeology as exact sciences.

The key to the Glacial period is found in the existing glaciers, which still cover about 10 per cent. of the land surface of the earth. The author is particularly well qualified to treat of the geology of the Ice Age as he has made a special study of the glacial phenomena in the French Pyrenees, where he found a succession of four terraces in the Garonne and Ariège valleys precisely as had been noted previously by Penck and Brückner in the foothills of the Alps. These he refers to the four glacial epochs for which he accepts Penck's terminology, beginning with the oldest: Günz, Mindel, Riss and Würm. In the Garonne valley the Günz terrace is 150 meters above the present stream bed; while the Mindel, Riss and Würm terraces are 100, 55 and 15 meters respectively above the present stream.

The great loess mantel stretching from southern England, Belgium and northern France across Germany to the Carpathian Mountains, Obermaier considers an eolian formation. His conclusion is based on the position, structure and content of the loess. In the Riesengebirge it reaches an elevation of 400 meters above the sea; the lines of stratification are not such as would be formed in water; and the animal remains found in the loess are for the most part land shells, freshwater shells being rare and fishes entirely wanting.

While the great loess mantel is evidently eolian, there are restricted loess deposits connected with valley terraces that owe their formation to the agency of water. The loess of western and central Europe is exclusively of Quaternary age, but must be considered as having been deposited at various epochs. The author believes the latest loess to be post-glacial, while Penck would place it as far back as the maximum extension of the Würm glaciation.

The possible causes of the Ice Age may be classed as astronomical, geological and physical. The basis for the astronomical theories is that the movement of the earth is influenced not only by the sun, but also by the planets; the latter, although much smaller than the sun, are nevertheless able to bring about periodic changes in the form of the earth's orbit and the inclination of the earth's axis to the ecliptic. The precision of the equinoxes should also be considered. No one of the periodic changes in the movement of the earth is sufficient in itself to bring about a succession of glacial and interglacial epochs.

From the viewpoint of geology the legends concerning the lost Atlantis, or those pointing to a possible bridge across the north Atlantic, must ever remain purely legends. Does the theory of Kreichgauer furnish a key to the Ice Age? The author thinks favorably of it. Kreichgauer supposes the earth's axis to remain fixed and the earth's crust to move slowly on the molten mass within. Thus a spot on the equator might in the course of time find itself over one of the poles. Paleontology and the distribution of glacial phenomena are thought to offer evidences in support of this hypothesis.

As possible physical causes there may be cited changes in the character of the atmosphere, rendering it less penetrable by the sun's rays. According to Svante Arrhenius, a period of high percentage of carbonic acid in the air would be a period of cold, and *vice versa*. Periods of great volcanic activity would thus correspond to periods of cold; and the Quaternary volcanoes of Auvergne and the Rhine are known to have been active during a cold period. Of all the theories, the author gives preference to Kreichgauer's. Whether the glacial epochs were synchronous in the northern and southern hemispheres he is un-

[1] The authors of the other volumes are Ferdinand Birkner, Wilhelm Schmidt, Ferdinand Hestermann and Theodor Stratmann.

able to say categorically. That there were four glacial epochs alternating with interglacial epochs is reflected in the changing character of the animal and plant world. The association of animal and plant remains with human skeletal remains, and especially artifacts, often serves to throw light on the age of the latter.

The author divides the lower paleolithic into early Chellean, Chellean, Acheulian and Mousterian, describing in detail not only the well-known type specimens, but also various small forms only recently recognized as belonging to the earlier horizons. Many important stations are described at length; and ample space is given to the geographic distribution of the successive cultures.

The author traces diluvial man over practically the whole earth. He sifts the evidence bearing on the presence of diluvial man in countries outside of Europe, finding indications of a Chelleo-Mousterian industry widespread over both hemispheres. He believes it to be diluvial, but not necessarily everywhere of the same age.

The types characterizing the various upper paleolithic industries are fully described and figured: Aurignacian, Solutrean and Magdalenian, each with its subdivisions. The use of the Magdalenian *bâton de commandement* remains problematic. Of the many theories advanced as to the purpose it served, Obermaier favors Reinach's supposition that they might have been magic wands, rather than clubs, halter pieces, tent fixtures, figulæ, hunting trophies or sceptors. Of the Azilian epoch, transition epoch from the paleolithic to the neolithic, the fauna is neolithic, but the culture is still paleolithic. Breuil's conclusions as to the sequence in the development of paleolithic parietal art are accepted. Quaternary art in Europe is analogous to the art of modern primitive man, but not to that of neolithic man in Europe.

The popular interest in a definite chronology for man's antiquity is perennial. Authorities still differ enough in their estimates to admit of being grouped into three classes; radicals, conservatives and a middle class. The author would place the Magdalenian, not during the Achen retreat, nor after the Bühl stage, but during the latter because of the reindeer fauna. In that respect he and Penck are practically in accord, although Penck believes the Magdalenians were living somewhere also during the maximum Würm cold as well as during the Achen stage. By giving to the Magdalenians more latitude in point of time, Penck finds it convenient to push back the Mousterian epoch much further than Obermaier would have it go. Both believe that the Mousterians passed through a cold and a warm stage. Penck allows for this by placing the early Mousterians in the Riss glacial epoch and the later Mousterians in the first half of the succeeding Riss-Würm interglacial, and the upper Mousterian with the first advance and maximum of the Würm glaciation. Penck would have the Chellean and Acheulian correspond to the second interglacial epoch. Both agree in assigning the human lower jaw of Mauer to the Mindel-Riss interglacial epoch; the Mauer specimen thus represents for Penck Chellean man or pre-Chellean and for Obermaier pre-paleolithic man.

The difficulty of substituting an absolute for a relative chronology is at once evident to any one familiar with the character of the phenomena to be dealt with. The advance and retreat of glaciers has been studied in recent times. The rate of deposition and erosion within certain limits is subject to measurement. For a continental ice sheet to form and push its way out of the north until it reaches central Europe requires a long time; and it was not at once evicted from the outposts gained. Even after its maximum force was spent, it disputed stubbornly every inch of the territory on the retreat. This program with occasional halts and advances was repeated four times. The Würm glacial deposits look fresh in comparison to those of the Riss, for example, and still greater weathering is to be noted in the deposits left by the Mindel and Günz, respectively. The size of the Würm terminal moraine and the amount of material left as mantels on the retreat of

the ice, testify to the eroding and transporting power of the last glaciation, as well as to its long period of activity. The Riss terminal moraines and gravel beds are still greater; hence indicate a longer period of glaciation for the Riss epoch. If the various glacial epochs were of unlike duration, so also were the interglacial epochs. Penck finds that in the foothills of the Alps, where the gravel beds of the four glacial epochs appear as terraces, those of the first two epochs lie considerably higher than those of the last two. The valley erosion between the Mindel and the Riss epoch was, therefore, greater than that of the Riss-Würm interglacial epoch. On the other hand, the Riss-Würm is longer than the time that has elapsed since the maximum Würm extension. The alternation of cold and warm faunas confirms the theory of the relatively great length of time required. Since authorities do not agree as to the geological position of the various cultural epochs, it is not strange that they should also differ in their estimates concerning the absolute length of these epochs.

Obermaier admits that his own figures are ultra-conservative. He places the close of the neolithic age at about 2000 B.C., its beginning some 6000 B.C. The date separating the protoneolithic from the Magdalenian is 12000 B.C., the beginning of the Magdalenian at least 16000 B.C. To the Solutrean and Aurignacian each he ascribes 5,000 years, and to the Mousterian, Acheulian and Chellean each 10,000 years. He thus arrives at a minimum figure of 50,000 years for the time that has elapsed since the appearance of paleolithic man, and at least 100,000 years for the age of the pre-paleolithic Heidelberg jaw.

L. Pilgrim is much more liberal in his estimates for a chronology of the Ice Age, his total amounting to 1,290,000 years. Penck's figures are somewhat more conservative; he allows some 30,000 years for the time that has elapsed since the maximum Würm glaciation, 60,000 years for the Riss-Würm epoch, more than 240,000 years for the Mindel-Riss epoch, and for the entire duration of the Ice Age 1,000,000 years. Hildebrandt's estimate for the Quaternary is 580,000 years. Schlosser and Boule are inclined to regard the Günz epoch as belonging to the upper Pliocene.

Obermaier rightly rejects all human remains whose age is in doubt. After this is done there is still left a formidable list representing every culture horizon. The Tilbury skeleton is thought to be of Quaternary age, while the remains from Galley Hill, Engis, Furfooz, La Hastière, Trou Magrite, Goyet, Trou du Chaleux, Brüx and Podbaba, are set aside as uncertain. He believes that we must go back to Eocene times in order to find the bridge that connects man with the ancestors of living anthropoids and cites *Pithecanthropus erectus* as an example of how close an anthropoid line can come to the human without being or becoming a part of it. *Propliopithecus hæckeli*, a fossil ape from the Oligocene of Egypt, is probably the ancestor not only of Simiidæ, but also of Hominidæ.

The eolithic question is discussed at considerable length. It is contended that on mechanical grounds alone there is no way of distinguishing between man-made and nature-made eoliths. The so-called Tertiary and Quaternary eoliths are not accepted unless they are made of material foreign to the deposit in which they are found, or are associated with human bones, hearths or other indubitable evidence of man's presence. On the other hand, it is admitted that some primitive races of to-day are in the eolithic stage, that all eoliths may not be due to natural causes, and that the lower jaw from Mauer represents eolithic man.

In Part II. the reader has a handy résumé of the culture periods connecting the paleolithic with historic times; neolithic, bronze and iron ages. It is, however, in Part I. that the author speaks with special authority and from a wealth of first-hand knowledge. Professor Obermaier is to be congratulated on the completion of a work that will be admired alike for its magnitude and general excellence.

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The Meaning of Evolution. By Samuel Christian Schmucker, Ph.D. New York, The Macmillan Company. 1913. 12mo. Pp. 298.

This is a very readable book upon what is no longer a new theme. Following a literary "foreword" the pre-Darwinian history of evolution is sketched as a background for Darwin and Wallace. The historical chapter about Darwin presents the essentials of his career in a charmingly vivid and sympathetic manner. Then follows the "Underlying Idea" of natural selection as the method of evolution illustrated largely by means of the English sparrow, of which the author incidentally says (p. 84): "This pestiferous creature should be exterminated . . . but personally I am taking no share in his destruction . . . I confess that it would be with regret that I should see him disappear from the landscape."

Chapters IV. and V. deal with adaptation for the individual and for the species. The general attitude toward Lamarck is occasionally rather more conciliatory than the militant Weismannian would approve of, but this is not to be wondered at in one who is proud of having been a student of Professor Cope. It seems to be very easy to drop into Lamarckian explanations for adaptation. For instance (p. 89): "The modern scientist feels sure not only that the animal is fitted to his work, but that he has been so fitted by the work." It will probably always be a bone of contention whether the exercise of an organ determines its structure or the structure of an organ sets the limits to its exercise.

With respect to protective coloration and sexual selection the author proposes to retain the Darwinian interpretation until something better arises in spite of the recent loss of confidence in the adequacy of these explanations.

The three succeeding chapters upon "Life in the Past," "How the Mammals Developed," and "The Story of the Horse" marshal in review some of the classified evidence in support of animal evolution, while Chapter IX. takes up "Evolutionary Theories Since Darwin."

In this last chapter Weismann, whose name will doubtless be correctly spelled in subsequent editions, is justly given prominence because his "work has made us cautious and prevented our lightly accepting a belief in the influence of the environment." Moritz Wagner and Romanes with their isolation theories and the orthogenists receive attention, and finally Hugo deVries with mutation closes the chapter.

The book could have been written fifteen years ago so far as any analysis of the significant bearing which Mendelism or the pure-line theory of Johannsen has upon the question of evolution.

Chapter X. turns optimistically to the "Future Evolution of Man" and is sociological rather than biological in its treatment, while the final chapter, "Science and the Book" gives the impression that the professor has stepped out of the class room and is speaking to a church audience and speaking withal extremely well.

The word "Evolution" has lost most of its incendiary character of a generation ago yet there are no doubt many in whose minds it still stands contrasted with religion and the Bible as a faith-destroying invention of godless scientists. To all such persons this book is a welcome message of reassurance and peace while to others who no longer need to be convinced of the essential truth of the evolutionary processes, the pages will be turned with approving delight.

Dr. Schmucker has stated the facts of the case in clear non-technical language with much literary grace and with scientific accuracy, consequently the book is well adapted to a wide range of readers even outside the biologically initiated.

H. E. Walter

Brown University

Animals of the Past. By Frederick A. Lucas. American Museum of Natural History, Handbook series No. 4. New York. 1913. Pp. xx + 266, with a frontispiece and 50 full-page and text figures.

This volume is an exact reprint of Lucas's

"Animals of the Past," of which the last edition was published in 1902, with the addition of a prefatory note bearing a picture of the mounted skeleton of *Allosaurus* on the reverse side of the leaf, and a final chapter containing a retrospect of the last twelve years, and summarizing the latest additions to our knowledge, especially such as have been gained through the medium of exploration.

The printing is from the original plates, which ultimately became the property of the author, and the general appearance of the book, the paper cover of which bears Gleeson's spirited restoration of *Tylosaurus*, is of the degree of excellence which one is led to expect in publications of the American Museum.

Richard S. Lull
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A History of Chemistry from the Earliest Times to the Present Day. By the late James Campbell Brown, D.Sc., LL.D., Professor of Chemistry in the University of Liverpool. Philadelphia, P. Blakiston's Son & Co. 1913. Octavo. Pp. 558, with 107 illustrations. Cloth. $3.50 postpaid.

As stated by the editor (a cousin of the author) the present work comprises a course of lectures which the late Dr. Campbell Brown was accustomed to deliver before the chemistry students of Liverpool University. The lectures were left as manuscript notes which the author intended to revise for publication, but his sudden death in 1910 prevented the execution of this plan. Notwithstanding the imperfect shape of some of the material, the friends of the author considered that it would be a cause for regret if the information, which represented years of patient research and study were not made available to former students and to any others who might be interested in the history of chemistry. The lectures have, therefore, been printed, in much the same shape as delivered, the editor making such changes and revisions as seemed necessary for proper presentation in book form.

Following the example of Kopp (whose monumental "Geschichte der Chemie" must form a basis for every historian of chemistry) the author has divided his subject into five sections—the Prehistoric, the Alchemical, the Iatrochemical, the Phlogiston and the Quantitative Periods. The lectures upon the first four of these periods cover their ground most minutely, and indicate that the author must have had a particular fondness for ancient chemical lore. This section of the book is profusely illustrated with old drawings of alchemical apparatus, mystical diagrams and specimen pages of Greek, Syriac and Arabian texts. The lists of writers and of bibliographies are very full, making the book of service, both to those who wish to consult the old authors as well as to the collector of rare books. For the abundance of material supplied in this particular branch of chemical history, we know of no other book in English with which it can be compared.

In discussing the work of the ancient Greek and early medieval alchemists the author has made extensive use, as every historian of chemistry must, of the invaluable researches of Berthelot. The lecturer cautions his students to distinguish carefully between the genuine works of Democritus, Geber, etc., and those of their pseudo-namesakes; it seems that the editor has not heeded this caution in revising the late author's notes. The story told on page 30 of the miraculous opening which Democritus saw in the pillar of the temple at Memphis and the two prescriptions for making gold on page 31 are found in sections 3, 4 and 5, of the "Physica et Mystica," a work which belongs, as the author correctly states elsewhere (pp. 43, 182), to the pseudo-Democritus and not to the founder of the atomic school.

We fear that the remarks of the author upon page 14 regarding the chemical knowledge of the Hebrew law-giver Moses may cause considerable perplexity. The statement that Moses comminuted the golden calf and "rendered it soluble by fusion with an alkaline or alkaline-earthy sulphide" revives a strange speculation indulged in by the ancient alchemists. The verse in Exodus 32:20, which states that Moses took the golden calf "burnt it in the fire and ground it to powder and strewed it upon the water and made the

children of Israel drink it" stimulated the search for a life-giving tincture of gold (the *aurum potabile*). It was held that Moses possessed wonderful chemical knowledge, acquired from the Egyptians, and theories were advanced that he dissolved the golden image in *aqua regia* or else alloyed it with lead or mercury. Stahl in 1698 advanced the new explanation that Moses dissolved the gold by treatment with supersaturated liver of sulphur (*hepar sulphuris supersaturatum, ex æquis partibus salis alcali et sulphuris citrini*). From Stahl, evidently, the late author borrowed his own idea, which we can of course interpret only as a piece of lecture-room pleasantry.

The famous *ænigma chemicum* concerning the nine-lettered name of the philosopher's stone, which is translated in part on page 154, is another interesting example of the speculations in which alchemists were wont to indulge. The answer "arsenicon" which the author gives, is only one of many solutions that have been proposed; φαοσφόρος (phosphorus), κινάβαρις (cinnabar) κασίτερος (tin) and other Greek words have been distorted in a vain effort to meet the requirements of the riddle.

A critical reader might object to several statements in the book for reasons of inaccuracy. It is wrongly stated, for example, on page 17 that sugar was employed by the ancient Egyptians. The earliest reliable information—that found in old Chinese writings—places the probable date of the earliest manufacture of cane-sugar between A.D. 300 and 600. The σάκχαρ of Galen and σάκχαρον of Dioscorides and other Greek writers was not our modern cane-sugar, but in all probability the eastern *tabaschir*, a gummy silicious exudation of the bamboo.

The statement (p. 183) that Aristotle originated the idea of a fifth element (the ether or quintessence) requires to be modified. The same conception occurs earlier in Plato, who, in the Timæus (end of Chap. XX.), mentions a fifth substance or essence (ἐμπέπτη σύστασι), which included the four elements of fire, air, water and earth. This notion, which foreshadowed later assumptions concerning the unity of matter, is also found in the writings of the early Pythagoreans, from whom the idea was probably first borrowed.

The fifth section of the book was not finished by the late author and this part of the volume shows in consequence considerable evidences of incompleteness. Many of the chapters are in fact so fragmentary that a student can obtain only an imperfect and confused idea of modern chemistry. The chapter upon physiological chemistry, for example, makes no mention of the work of Claude Bernard and leaves the subject of fermentation where it was left by Dumas. The editor's arrangement of the author's lecture notes in this part of the book seems particularly unfortunate. We wonder, for example, in the grouping of chemists by chapters, why Wöhler was not associated with Liebig rather than with Stas, and why Bunsen was not placed with Kirchhoff rather than with Victor Meyer. There is also in places a lack of agreement between different sections. The discovery of columbium, for example, is credited to Wallaston in 1809 on page 348 and to Hatchett in 1801 on page 521. In some ways it would have been better to have closed the history with the end of the life-work of Liebig and Dumas. This marks fairly well the end of an epoch and would have enabled the editor to eliminate fragmentary chapters and thus give the book a greater appearance of finish.

The typography of the new book is, as a whole, excellent. The method of printing the formulas of propyl and isopropyl iodides on page 469 is faulty, as it gives them the appearance of being unsaturated compounds. There are also several cases of careless typesetting, a most glaring instance being the heading of chapter 32.

A posthumous work published under adverse conditions must necessarily receive due consideration for evidences of incompleteness and mistakes of revision. After a careful reading of the book, we believe that the publication of Dr. Campbell Brown's lectures upon the history of chemistry was well worth while. The finely

executed photograph of the author and the nine-page biographical sketch will be appreciated by those who knew him and to those unfamiliar with his life will convey the pleasing impression of a strong unique personality.

C. A. Browne

CHINA'S FOREIGN TRADE IN MEDIEVAL TIMES

The history of commercial intercourse, bound up as it is with the history of the origin and development of navigation, is a most fascinating subject, more especially the study of the commercial relations between the different Oriental peoples. A valuable contribution to this subject has recently been issued by Professor Friedrich Hirth, of Columbia University, and Mr. W. W. Rockhill. This is a translation from the Chinese, with introduction and commentary, of the work by Chau Ju-Kua, treating primarily of products, and incidentally of the customs of the various countries known to the Chinese in the twelfth and thirteenth centuries of our era. The introduction by the translators supplies us with much valuable information on Chinese trade derived from a number of other sources.[1]

Of the many interesting facts to be gleaned from a perusal of this book, we can only very briefly touch upon a few of the more striking. The work appeals especially to careful and thorough students of the subject.

The trade of Canton was the object of earnest solicitude to the Chinese government, because of the large revenue derivable from it. One of the port regulations implies a determination to give all importers an equal chance, as far as possible, for as each ship arrived its cargo was discharged, and the merchandise placed in the government storehouses and kept there until the last ship of the season sailed in. Only then were goods placed at the owners' disposal for sale, the government retaining thirty per cent. as customs duties. Thus the first comer was not allowed to secure the cream of the market to the prejudice of those who might have had a longer voyage, or else have been detained by stress of weather.[2]

Toward the close of the tenth century the Chinese government, realizing the great value of its Canton trade, undertook an active propaganda to encourage its development, envoys being despatched with the wherewithal to secure the good-will of the South Sea traders. Among other inducements special trading licenses were offered. The results were soon apparent, merchandise poured in so freely that the difficulty was to find a good market for it. The rapid increase under this fostering care is shown by the fact that while from 1049 to 1053, elephants' tusks, rhinoceros horns, strings of pearls, aromatics, incense, etc., were annually imported to the value of 53,000 "units of count," these annual imports had risen in 1175 to over 500,000 "units of count." While the monetary equivalent is an unknown quantity, the figures suffice to show the great increase of the Canton trade.[3]

The government import duties amounted to thirty per cent. from the middle of the ninth century A.D. and this rate remained practically unchanged for several centuries thereafter. If any part of a ship's cargo was removed without the knowledge of the officials the whole cargo was confiscated and the offender was punished according to the gravity of the offense. Therefore we need not wonder that a Chinese authority (the Pingchou-k'o-t'an) should be able to state: "so it is that traders do not dare to violate the regulations."[4]

The Chinese author does not confine himself to a description of the chief productions of each of the regions he passes in review, although this is the principal aim of his work, but he also gives many brief notes regarding the customs, dress, etc., of the different peoples and details of the court ceremonials.

[1] Chau Ju-Kua = his work on the Chinese and Arab trade in the twelfth and thirteenth centuries, entitled "Chu-fan-chi." Translated from the Chinese and annotated by Friedrich Hirth and W. W. Rockhill, St. Petersburg, Printing Office of the Imperial Academy of Sciences, 1911. Pp. x + 288. 8°.

[2] *Op. cit.*, p. 15.

[3] *Op. cit.*, p. 19.

[4] *Op. cit.*, p. 21.

Of the Annamese we learn that the king usually rode on an elephant when he appeared in public; sometimes he was borne in a sort of hammock by four men. At court ceremonies his throne was surrounded by thirty female attendants, armed with sword and buckler. A curious custom in warfare was to bind five men together in one file; if one tried to run away the whole file was condemned to death.

The implicit faith in the virtue of written charms is illustrated by the proceedings to be taken when one of the people was killed by a tiger or a crocodile. In this case the high priest was ordered to write out a number of charms and scatter them about at the spot where the person was killed. Such was believed to be the power of the charm that the guilty animal would be invariably attracted to the place, but before he could be done away with, a royal order had to be secured.[5]

The jewel treasures of Ceylon always excited the wonder and admiration of the early travelers to that island, and Chau Ju-Kua is no exception to this rule. His description of the king's personal appearance is scarcely flattering. He is black, with unkempt hair and bare head, his body only covered with a cotton cloth of various colors wound about him, but of his abode we read:[6]

"His palace is ornamented with cat's-eyes, blue and red precious stones, carnelians and other jewels; the very floor he walks upon is so ornamented. There is an eastern and western palace, and at each there is a golden tree, the trunk and branches all of gold, the flowers, fruit and leaves of cat's-eyes, blue and red precious stones, and such like jewels. At the foot of these trees are golden thrones with opaque glass screens. When the king holds his court he uses the eastern palace in the forenoon and the western in the afternoon. When (the king) is seated, the jewels flashing in the sunshine, the glass (screens) and the jewel-trees shining on each other, make it like the glory of the rising sun.

"The king holds in his hand a jewel five inches in diameter, which can not be burnt by fire, and which shines (in the darkness of) night like a torch. The king rubs his face with it daily, and though he were passed ninety he would retain his youthful looks."

The throne of the king of Cambodia was made of "the seven precious substances," with a jeweled dais and an ivory screen. He was said to have 200,000 war elephants—a glaring exaggeration—and four large bronze elephants, each weighing 4,000 catties, stood as guards about a bronze tower or temple in the capital.

A strange test of true royalty is noted in Palembang, eastern Sumatra. Here the royal cap was of gold, studded with hundreds of precious stones, and of such crushing weight that few were able to wear it. On a king's demise all his sons were summoned together and the one who proved strong enough to bear the weight of this cap was proclaimed as the new sovereign.

The few details we have cited from this work will give some idea of the interest and value of the volume, and the full and scholarly notes with which it has been so liberally provided by its translators and editors add much to its worth as a book of reference.

GEORGE F. KUNZ

[5] *Op. cit.*, pp. 47, 48.

[6] *Op. cit.*, pp. 72, 73.

SPECIAL ARTICLES

FURTHER EXPERIMENTS ON OVARIAN TRANSPLANTATION IN GUINEA-PIGS

FOR several years we have been engaged in studying the effects of ovarian transplantation upon the inherited color characters of young guinea-pigs developing from eggs liberated by a transplanted ovary. Our method has been to transplant the ovary taken from an animal of one color variety into the body of an animal of a different color variety and then to observe whether the young showed the color characters of the mother which bore the young or of the animal which furnished the ovary, or of both. In 1909[1] we reported the first crucial experiment bearing on this ques-

[1] "A Successful Ovarian Transplantation in the Guinea-pig and its Bearing on Problems of Genetics," SCIENCE, N. S., Vol. 30, pp. 312–314. 1909.

tion, which was more fully described with illustrations in 1911.[2] In a postscript to our 1911 publication we described a second crucial case, and it is the purpose of this note to record a third.

In the first case, the ovaries of a black guinea-pig were transplanted into the body of a white one, where they developed and liberated ova for a period of more than one year, in the course of which six young were produced, all black-coated like the animal which furnished the ovary, but not like the animal which bore the young. The foster mother differed from the animal which furnished the graft, to the best of our knowledge, by only a single genetic color factor. The ovarian tissue taken from the black animal evidently possessed this factor (the so-called "color-factor") and retained it throughout its sojourn in the body of the albino, for it was transmitted in the eggs liberated within the body of the albino, a thing which never occurs in normal albinos.

In the second case, as in the first, the same color-factor difference existed between the animal which furnished the graft and the one which received it, the latter being an albino, the former colored, while as regards other color-factors graft and grafted were alike. But in Case 1, as already stated, the colored animal was black and the albino was a *potential* black, lacking color; whereas in Case 2 the colored animal was brown-eyed cream and the albino was a *potential* brown-eyed cream, lacking color. In the pair of animals used in Case 1 two color-factors occurred which were lacking (or different) in Case 2. In Case 1 *black* and *extension* of color were present in graft and grafted animal alike; in Case 2 these were replaced by *brown* and *restriction* respectively. Nevertheless the same negative result was observed in both cases as regards the effects of grafting. In Case 2, the grafted albino foster mother bore a brown-eyed cream young one by an albino mate. She also bore two albino young, but this is not to be regarded as evidence of somatic influence of the foster mother, for it is known that animals of the stock of guinea-pigs which furnished the graft were heterozygous in albinism, so that the ovarian tissue would be expected to furnish equal numbers of ova transmitting the brown-eyed cream character and albinism, respectively. As we said in 1911, "The character of the young obtained and their numerical proportions are exactly such as the colored animal herself would have been expected to give had she not been sacrificed to furnish the grafts but had been mated with the albino male."

The third (and new) case involves a wholly different factor, the *agouti* hair pattern, both animals being colored and alike, so far as known, in all genetic factors except the agouti. For both were *brown* pigmented (not black), with *extended* (not restricted) pigmentation, and in the families of both albinism occurred as a recessive character. The grafted animal in this case was a brown (or "chocolate") animal, No. 2,562. Her parents were of the same color. At about six weeks of age, on June 9, 1910, she was castrated and then received the ovaries from female No. 2,564, a light cinnamon guinea-pig about one month old, and of the same color variety as her parents. On either side of the body an ovary was stitched to the "horn" of the uterus about a centimeter from the normal position of the ovary. After recovery the grafted animal was placed in a pen with male 2,420, an albino whose parents were brown-eyed cream. From a mating with this animal the expectation would be that a brown mother would produce brown young (or albinos potentially brown), while a cinnamon mother would produce cinnamon young (or albinos potentially cinnamon).

The grafted mother produced five young as follows: In November, 1910, a male albino; on June 25, 1911 (more than a year after the operation), a female light cinnamon, No. 2,986; on September 1, 1911, a male light cinnamon-and-yellow, No. 3,016; on November 10, 1911, a male albino; on January 29, 1912, a female albino.

[2] "On Germinal Transplantation in Vertebrates," Carnegie Institution of Washington, Publ. No. 144, 26 pp., 2 pl. 1911.

On July 15, 1912, over two years after the operation, the grafted mother was noted as still having well-developed mammæ and genitalia, as if she possessed functional ovarian tissue. On November 25, 1912, she died and there was found *post mortem* a large cyst in the uterus on the right side, and on the left side at the site of the graft a large ovarian mass, doubtless the source of the functional ova liberated during the two years previous. No microscopic study of this tissue was made, as it was already in an advanced stage of decomposition when observed.

To summarize the record, two of the five young were colored, and three were albinos. Both of the colored young were cinnamon, like the graft producer, rather than brown like the foster mother. As regards the albinos, it remained to ascertain whether they were *potential cinnamons* or *potential browns*. This required a breeding test which we were able to complete in the case of one of the three only. This animal, a male, when mated with brown females, produced two brown and one cinnamon young, showing that he was potentially a cinnamon though heterozygous for brown. He had accordingly inherited cinnamon from his foster mother, or rather from the graft which she contained, for his albino father did not transmit cinnamon. This could be inferred from the fact that the brown-eyed cream ancestors of the albino father were known not to transmit cinnamon, but it was further established by mating him with brown females, by which he produced five brown young and two albinos but no cinnamons.

If, as stated, the albino father, No. 2,420, did not transmit cinnamon, then his cinnamon offspring, or *potential cinnamon* albino offspring, by the grafted brown mother, would have to be merely *heterozygous* in cinnamon. Therefore, we should expect only half of *their* young to be cinnamon, when they were mated with brown animals. The potential cinnamon albino, as already noted, when so mated, had one cinnamon and two brown young.

Finally, the cinnamon female, No. 2,986 borne by the grafted mother, was mated with her albino father (*potentially* a brown-eyed cream, since his parents were of that recessive variety). She produced eight young, of which five were brown-eyed creams, two albinos and one a cinnamon; expectation 2:4:1. The production of a cinnamon young one in this mating shows that the cinnamon animal not only inherited but also transmitted the cinnamon character, as if her mother had been a cinnamon animal instead of a cinnamon graft in a brown animal. The sojourn and development, in the body of a brown animal, of an ovary taken from a cinnamon animal does not seem to have altered in any respect the initial genetic potentialities of the germinal substance.

These three cases form a substantial body of evidence in favor of the view originally advanced by Weismann that in the higher animals germinal substance and body are physiologically distinct, and that the genetic potentialities of the latter are not subject to modification through somatic influence.

It may be of interest to note that in our entire work 141 female guinea-pigs were grafted with foreign ovaries. Of these about 100 were mated with males long enough to give definite indications of their ability to produce young. Only 3, as noted, actually produced young, but in 7 others engrafted ovarian tissue persisted for many months and was demonstrated *post mortem*. In 11 cases ovarian tissue was regenerated at the original ovarian site and in 3 of these cases young were produced having the genetic characters of the mother, but never those of the graft. In 87 cases no ovarian tissue whatever was found *post mortem*, the castration having been completely successful but the transplanted ovaries having failed to persist for any length of time in the foreign body.

The small percentage of successful transplantations indicates that the method is not likely to be useful practically in the domestic animals or man unless some means can be discovered for increasing the tolerance of the body to foreign tissues. We have considered in this connection the possibility of increasing this tolerance by holding the tissue to be

transplanted for a time in an artificial nutrient medium or even in serum from the animal to be grafted, allowing thus a preliminary adjustment to the new environment, but have had no opportunity to give such methods a trial. They are mentioned as possible suggestions for some one who may be able to attack the problem fully equipped with a knowledge of the principles governing immunity and anaphylaxis.

This investigation has been carried out in the Bussey Institution with assistance from the Carnegie Institution of Washington.

W. E. Castle,
John C. Phillips

The Bussey Institution
Harvard University

NUTRITION AND SEX DETERMINATION IN ROTIFERS

In an interesting paper in the August, 1913, number of the *Journal of Experimental Zoology,* Claude W. Mitchell communicates a series of observations and experiments upon the rotifer *Asplanchna,* from which he draws conclusions at variance with those hitherto advanced by investigators who have worked with *Hydatina.* His main conclusion, it appears to me, is that "qualitative and quantitative changes in nutrition will be found the universal sex-controlling factor in this group" (rotifers). If it be granted that other factors than nutrition also play the same role in sex determination in one rotifer as in another, I think it may be shown that Mitchell's experiments are not calculated to prove his contentions.

There is, in the first place, some obscurity in the use of the word "nutrition." By the earlier workers on life cycles in rotifers and daphnians, nutrition was measured by the quantity of available food. The rate of reproduction gave a key to the degree of nutrition, but the rate of reproduction was supposed to be proportional to the amount of available food. It is obvious, however, that nutrition may be measured by the quantity of food that an organism can *assimilate,* which may be independent of the amount *available.* In rotifers, for example, there are periods in which reproduction and growth are rapid, alternating with periods in which these processes are slow. Mitchell does the service to emphasize this "physiological rhythm." Rotifers in the period of rapid growth will live well under external food conditions that would reduce rotifers in a period of depression almost to starvation.

When we say that nutrition determines sex, what meaning do we put upon nutrition? One might assume that Mitchell regards nutrition and physiological "level," to use another term of his, as synonymous, were it not that in the seventh paragraph of his summary he lists them separately. To quote:

> Maximum male production is determined by three factors, physiological rhythm, high nutrition and starvation during the growth period.

If nutrition means the quantity of food available, the evidence in its favor as a sex determinant is so small as to be negligible. The experiments of Mitchell do not prove its effectiveness in *Asplanchna,* as I hope to show below, and my own work on *Hydatina* is not only distinctly against it, but explains away the positive results of Nussbaum. If nutrition means the quantity of food that can be assimilated, then high nutrition is probably the result of an antecedent physiological change that is not nutrition at all. Rhythms of reproduction and growth occur in *Hydatina,* in protozoa, in *Cladocera,* and perhaps many other animals; but so far as I know, the physiological change preceding a wave of rapid growth has not been discovered. It may be a chromosomal change. If the wave of rapid reproduction is accompanied by a wave of many male producers, it seems to me we are much more justifiable in assuming that both high nutrition and male production are here the result of some other physiological factor, than in holding the male production to be a result of the nutrition. That the evidence of high nutrition comes earlier in a series of generations than does the evidence of male production may be due to the fact, true at least for *Hydatina,* that sex is determined a generation in advance without any visible sign of such determination. I revert to this point,

apparently overlooked by Mitchell, below in another connection.

If my interpretation of physiological rhythm be correct, as outlined in the preceding paragraph, nutrition and male production stand in the relation, not of cause and effect, but of two effects of some cause. If this interpretation is correct, high nutrition and male production are not inseparable; and there is evidence that they are separable. Early in my work on *Hydatina* I noticed that periods of abundant male production were also periods of rapid growth (the fact which Mitchell emphasizes for *Asplanchna*), and I was almost convinced that anything which increased metabolism would also increase the proportion of male-producers.[1] But in healthy lines I later found that long periods were passed through in which the rate of growth and reproduction was very rapid, yet not a single male-producer appeared. In one instance, there were twelve successive generations in which no family comprised less than 46 daughters, some of them over fifty, which is almost the maximum of all my records. At the same time the females laid 16 to 22 eggs per day, depending on temperature, quite as rapidly as in the waves in which I had previously noted large numbers of male-producers. Yet not one male-producer appeared in these twelve generations. Hence, when actual counts were made from numerous families, for the purpose of proving that rapid metabolism and male production were interdependent, that thesis could not be established. While periods of many male-producers were on the whole periods of rapid metabolism, not every period of rapid metabolism was a period of many male-producers. Rapid metabolism could occur without abundant male production. One is driven, it seems to me, to the conclusion that when male production and rapid assimilation ("nutrition") occur simultaneously, both are probably effects of one cause; but that rapid assimilation may have other causes which do not at the same time cause abundant male production.

Mitchell does not, however, rely wholly upon the high nutrition which accompanies physiological rhythm to explain male production. The "nutrition" which depends upon the available supply of food is also held accountable; for the author conducts experiments in which the food supply is altered, and obtains what he believes to be positive results thereby. The general conclusion from these nutrition experiments is that "male production follows upon the summation of favorable external and internal conditions, plus a sudden interruption by a nutritive check." This check is starvation. The experiments, however, appear to me, for reasons about to be stated, quite inadequate. For example, one experiment consisted in isolating females from periods of rapid metabolism and from periods of depression, starving their offspring for a period after birth, and noting whether the daughters were male- or female-producers. Each part of this experiment involved only about ten individuals. Notwithstanding great irregularities in the occurrence of male-producers, irregularities which the author admits sufficiently to explain certain exceptions, the ten individuals are considered valid evidence. The apparent lawlessness of the occurrence of male-producers is sometimes astonishing. In *Hydatina,* in an extreme case, two sisters, the fourth and fifth, respectively, in their family, reared under what were aimed to be identical conditions, each produced a family of over forty. One family comprised over fifty per cent. of male-producers, the other none at all. In view of such irregularities, experiments including less than eight or ten generations have in my work been regarded with suspicion, unless the effects were quite marked. If such irregularities in the occurrence of male-producers are found in *Asplanchna,* ten individuals do not form a basis for conclusions.

Furthermore, it is questionable whether starvation can have such an effect *on the individual starved* as to change a female-producer to a male-producer. I have shown for *Hyda-*

[1] So nearly convinced was I that this relation existed, that I expressed the idea before a public gathering at the laboratory of the Brooklyn Institute of Arts and Sciences at Cold Spring Harbor, in the summer of 1909, but never in any published work.

tina[2] that it is irrevocably decided during the growth period of an egg whether the female that hatches from that egg will be a male-producer or a female-producer. This is actually proved, it is true, only so far as the effect of chemical substances is concerned. But I am unable to take comfort in the view that sex is determined at a given moment beyond the possibility of reversal by chemical substances, while it is still open to alteration by other external agents. If sex is determined thus a generation in advance in *Asplanchna*, as in *Hydatina*, the starvation experiments referred to above could not have produced positive results; the starvation should have been practised on the mother of the desired male-producer.

In another experiment Mitchell starves a number of young females for a few hours after birth. The first few daughters in each of nine families are used as controls (well fed); they include six male-producers out of a total of 39. The later daughters of the same families are starved; 51 out of 68 prove to be male-producers. The author attributes the higher proportion of male-producers in the latter lot to the check upon nutrition. But, waiving the objection of a rather small number of individuals, another explanation is at hand. It has been shown[3] from 349 families of *Hydatina*, comprising about twelve thousand individuals, that the first few daughters of a family are much less likely to be male-producers than are the later members. If the same relation holds in *Asplanchna*, the numbers of male-producers obtained in the experiment described are about what would have been expected if starvation had not been practised.

In offering this criticism of Mitchell's work I do so in no carping spirit. It is gratifying to find some one using the excellent material which *Asplanchna* affords in an attempt to solve fundamental problems. I have sought only to show wherein lie the weaknesses of the evidence.

A. Franklin Shull

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[2] Shull, A. F., "Studies, etc., III. Internal Factors Affecting the Proportion of Male-producers," *Jour. Exp. Zool.*, Vol. 12, No. 2, February, 1912.

[3] Shull, A. F., "Studies, etc." I., *Jour. Exp. Zool.*, Vol. 8, No. 3, May, 1910.

THE AMERICAN PHYSICAL SOCIETY

A regular meeting of the Physical Society was held in Fayerweather Hall, Columbia University, New York City, on Saturday, October 18, 1913. The following papers were presented:

"The Vapor Pressure of Metallic Tungsten," by Irving Langmuir.

"The Form of the Ionization by Impact Function, $a/p = f\ (x/p)$," by Bergen Davis.

"Change of State Solid-liquid at High Pressure," by P. W. Bridgman.

"Notes on Some Integrating Methods in Alternating Current Testing," by Frederick Bedell.

"Silvered Quartz Fibers of Low Resistance Obtained by Cathode Spray," by Horatio B. Williams.

"The Critical Ranges A_2 and A_3 of Pure Iron," by G. K. Burgess and J. J. Crowe.

"A Spectrophotometric Study of the Absorption, Fluorescence and Surface Color of Magnesium Platinum Cyanide," by Frances G. Wick.

"Examination of the Omnicolored Screen Plate by Means of Microscope and Spectroscope," by John B. Taylor.

"Relativity Theory—General Dynamical Principles," by Richard C. Tolman. (By title.)

"The Hall Effect in Liquid and Solid Mercury," by W. N. Fenninger.

"An Electrolytic Determination of the Ratio of Silver to Iodine and the Value of the Faraday," by G. W. Vinal and S. J. Bates.

"Effect of Amalgamation on the Contact E.M.F. of Metals," by F. J. Rogers.

"Relativity Theory; The Equipartition Law in a System of Particles," by Richard C. Tolman. (By title.)

"Failure of Color Photography by Commercial Screen-plate Methods for Spectroscopic Records," by John B. Taylor.

"Condition Involving a Decrease of Primary Current with Increasing Secondary Current," by F. J. Rogers.

"Experiments on the Magnetic Field of Two Electromagnets in Rotation," by S. J. Barnett.

"The Effect of Space Charge and Residual Gases on the Thermionic Current in a High Vacuum," by Irving Langmuir.

Alfred D. Cole,
Secretary

SCIENCE

FRIDAY, DECEMBER 5, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE HUMAN WORTH OF RIGOROUS THINKING[1]

But in the strong recess of Harmony,
Established firm abides the rounded Sphere.
—Empedocles.

AMONG the agencies that ameliorate life, what is the rôle of rigorous thinking? What is the rôle of the spirit that aspires always to logical righteousness, seeking "to frame a world according to a rule of divine perfection"?

Evidently that question is not one for adequate handling in an hour's address by an ordinary student of mathematics. Rather is it a subject for a long series of lectures by a learned professor of the history of civilization. Indeed so vast is the subject that even an ordinary student of mathematics can detect some of the more obvious tasks such a philosophic historian would have to perform and a few of the difficulties he would doubtless encounter. It may be worth while to mention some of them.

Certainly one of the tasks, and probably one of the difficulties also, would be that of securing an audience—an audience, I mean, capable of understanding the lectures, for is not a genuine auditor a listener who understands? To understand the lectures it would seem to be necessary to know what that is which the lectures are about—that is, it would be necessary to know what is meant by rigorous thinking. To know this, however, one must either have consciously done some rigorous thinking or else, at the very least, have examined some specimens

[1] An address delivered before the Mathematical Colloquium of Columbia University, October 13, 1913.

of it pretty carefully, just as, in order to know what good art is, it is, in general, essential either to have produced good art or to have attentively examined some specimens of it, or to have done both of these things. Here, then, at the outset our historian would meet a serious difficulty, unless his audience chanced to be one of mathematicians, which is (unfortunately) not likely, inasmuch as the great majority of mathematicians are so exclusively interested in mathematical study or teaching or research as to be but little concerned with the philosophical question of the human worth of their science. It is, therefore, easy to see how our lecturer would have to begin.

Ladies and gentlemen, we have met, he would say, to open a course of lectures dealing with the rôle of rigorous thinking in the history of civilization. In order that the course may be profitable to you, in order that it may be a course in ideas and not merely or mainly a verbal course, it is essential that you should know what rigorous thinking is and what it is not. Even I, your speaker, though a historian, might reasonably be held to the obligation of knowing that.

It is reasonable, ladies and gentlemen, it is reasonable to assume, he would say, that in the course of your education you neglected mathematics, and it is, therefore, probable or indeed quite certain thât, notwithstanding your many accomplishments, you do not quite know, or rather, perhaps I should say, you are very far from knowing, what rigorous thinking is or what it is not. Of course, as you know, it is, generally speaking, much easier to tell what a thing is not than to tell what it is, and I might, he would say, I might proceed by way of a preliminary to indicate roughly what rigorous thinking is not. Thus I might explain that rigorous thinking, though much of it has been done in the world, and though it has produced a large literature, is nevertheless a relatively rare phenomenon. I might point out that a vast majority of mankind, a vast majority of educated men and women, have not been disciplined to think rigorously even those things that are most available for such thinking. I might point out that, on the other hand, most of the ideas with which men and women have constantly to deal are as yet too nebulous and vague, too little advanced in the course of their evolution, too little refined and defined, to be available for concatenative thinking and rigorous discourse. I should have to say, he would add, that, on these accounts, most of the thinking done in the world on a given day, whether done by men in the street or by farmers or factory-hands or merchants or administrators or physicians or lawyers or jurists or statesmen or philosophers or men of letters or students of natural science or even mathematicians (when not strictly employed in their own subject), comes far short of the demands and standards of rigorous thinking.

I might go on to caution you, our speaker would say, against the current fallacy, recently advanced by eloquent writers to the dignity of a philosophical tenet, of regarding what is called successful action as the touchstone of rigorous thinking. For you should know that much of what passes in the world for successful action proceeds from impulse or instinct and not from thinking of any kind; you should know that no action under the control of non-rigorous thinking can be strictly successful except by the favor of chance or through accidental compensation of errors; you should know that most of what passes for successful action, most of what the world applauds and even commemorates as successful action, so far from being really

successful, varies from partial failure to failure that, if not total, would at all events be fatal in any universe that had the economic decency to forbid, under pain of death, the unlimited wasting of its resources. The dominant animal of such a universe would be in fact a superman. In our world the natural resources of life are superabundant, and man is poor in reason because he has been the prodigal son of a too opulent mother. But, ladies and gentlemen, our speaker will conclude, you will know better what rigorous thinking is not when once you have learned what it is. This, however, can not well be learned in a course of lectures in which that knowledge is presumed. I have, therefore, to adjourn this course until such time as you shall have gained that knowledge. It can not be gained by reading about it or hearing about it. The easiest way, for some persons the only way, to gain it is to examine with exceeding patience and care some specimens, at least one specimen, of the literature in which rigorous thinking is embodied. Such a specimen, he could say, is Dr. Thomas L. Heath's magnificent edition of Euclid where an excellent translation of the "Elements" from the definitive text of Heiberg is set in the composite light of critical commentary from Aristotle down to the keenest logical microscopists and histologists of our own day. If you think Euclid too ancient, and too stale even when seasoned with the wit of more than two thousand years of the acutest criticism, you may find a shorter and possibly a fresher way by examining minutely such a work as Veronese's "Grundzüge der Geometrie" or Hilbert's famous "Foundations of Geometry" or the late Pieri's "Della Geometria elementare come sistemi ipotetico-deduttivo." In works of this kind, of which the growing number is rather large, and not elsewhere, you will find, in its nakedness, purity and spirit, what you have neglected and what you need. You will note that in the beginning of such a work there is found a system of assumptions or postulates, discovered the Lord only and a few men of genius know where or how, selected perhaps with reference to simplicity and clearness, certainly selected with respect to their compatibility and independence, and, it may be, with respect also to categoricity. You will not fail to observe with the utmost minuteness, and from every possible angle, how it is that upon these postulates as a basis there is built up by a kind of divine masonry, little step by step, a stately structure of ideas, an imposing edifice of rigorous thought, a towering architecture of doctrine that is at once beautiful, austere, sublime and eternal. Ladies and gentlemen, our speaker will say, to accomplish that examination will require twelve months of pretty assiduous application. The next lecture of this course will be given one year from date.

On resuming the course what will our philosopher and historian proceed to say? He will begin to say what, if he says it concisely, will make up a very large volume. Room is lacking here, even if competence were not, for so much as an adequate outline of the matter. It is possible, however, to draw with confidence a few of the larger lines that would have to enter such a sketch.

What is it that our speaker will be obliged to deal with first? I do not mean obliged logically or obliged by an orderly development of his subject. I mean obliged by the expectation of his hearers. Every one can answer that question. For presumably the audience represents the spirit of the times, and this age is, at least to a superficial observer, an age of engineering. Now, what is engineering? Well, the charter of the Institution of Civil

Engineers tells us that engineering is the "art of directing the great sources of power in Nature for the use and convenience of man." By Nature here must be meant external or physical nature, for, if internal nature were also meant, *every* good form of activity would be a species of engineering, and may be it is such, but that is a claim which even engineers would hardly make and poets would certainly deny. Use and convenience—these are the key-bearing words. It is perfectly evident that our lecturer will have to deal first of all with what the world would call the "utility" of rigorous thinking, that is to say, with the applications of mathematics and especially with its applications to problems of engineering. If he really knows profoundly what mathematics is, he will not wish to begin with applications or even to make applications a major theme of his discourse, but he must, and he will do so uncomplainingly as a concession to the external-mindedness of his time and his audience. He will not only desire to show his audience applications of mathematics to engineering, but, being a historian of civilization, he will especially desire to show them the development of such applications from the earliest times, from the building of pyramids and the mensuration of land in ancient Egypt down to such splendid modern achievements as the designing and construction of an Eads bridge, an ocean *Imperator* or a Panama canal. The story will be long and difficult, but it will edify. The audience will be amazed at the truth if they understand. If they do not understand the truth fully, our speaker must at all events contrive that they shall see it in glimmers and gleams and, above all, that they shall acquire a feeling for it. They must be led to some acquaintance with the great engineering works of the world, past and present; they must be given an intelligent conception of the immeasurable contribution such works have made to the comfort, convenience and power of man; and especially must they be convinced of the fact that not only would the greatest of such achievements have been, except for mathematics, utterly impossible, but that such of the lesser ones as could have been wrought without mathematical help could not have been thus accomplished without wicked and pathetic waste both of material resources and of human toil. In respect to this latter point, the relation of mathematics to practical economy in large affairs, our speaker will no doubt invite his hearers to read and reflect upon the ancient work of Frontinus on the "Water Supply of the City of Rome" in order that thus they may gain a vivid idea of the fact that the most *practical* people of history, despising mathematics and the finer intellectualizations of the Greeks, were unable to accomplish their own great engineering feats except through appalling waste of materials and men. Our lecturer will not be content, however, with showing the service of mathematics in the prevention of waste; he will show that it is indispensable to the productivity and trade of the modern world. Before quitting this division of his subject he will have demonstrated that, if all the contributions which mathematics has made, and which nothing else could make, to navigation, to the building of railways, to the construction of ships, to the subjugation of wind and wave, electricity and heat, and many other forms and manifestations of energy, he will have demonstrated, I say, and the audience will finally understand, that, if all these contributions were suddenly withdrawn, the life and body of industry and commerce would suddenly collapse as by a paralytic stroke, the now splendid outer tokens of material civilization would perish, and the face of our

planet would quickly assume the aspect of a ruined and bankrupt world.

As our lecturer has been constrained by circumstances to back into his subject, as he has, that is, been compelled to treat first of the service that mathematics has rendered engineering, he will probably next speak of the applications of mathematics to the so-called natural sciences—the more properly called experimental sciences—of physics, chemistry, biology, economics, psychology, and the like. Here his task, if it is to be, as it ought to be, expository as well as narrative, will be exceedingly hard. For how can he weave into his narrative an intelligible exposition of Newton's "Principia," Laplace's "Mécanique Céleste," Lagrange's "Mécanique Analytique," Gauss's "Theoria Motus Corporum Cœlestium," Fourier's "Théorie de la Chaleur," Maxwell's "Electricity and Magnetism," not to mention scores of other equally difficult and hardly less important works of a mathematical-physical character? Even if our speaker knew it all, which no man can, he could not tell it all intelligibly to his hearers. These will have to be content with a rather general and superficial view, with a somewhat vague intuition of the truth, with fragmentary and analogical insights gained through settings-forth of great things by small; and they will have to help themselves and their speaker, too, by much pertinent reading. No doubt the speaker will require his hearers, in order that they may thus gain a tolerable perspective, to read well not only the two volumes of the magnificent work of John Theodore Merz dealing with the history of European thought in the nineteenth century, but also many selected portions of the kindred literature there cited in richest profusion. The work treats mainly of natural science, but it deals with it philosophically, under the larger aspect, that is, of science regarded as thought. By the help of such literature in the hands of his auditors, our lecturer will be able to give them a pretty vivid sense of the great and increasing rôle of mathematics in suggesting, formulating and solving problems in all branches of natural science. Whether it be with "the astronomical view of nature" that he is dealing, or "the atomic view" or "the mechanical view" or "the physical view" or "the morphological view" or "the genetic view" or "the vitalistic view" or "the psychophysical view" or "the statistical view," in every case, in all these great attempts of reason to create or to find a cosmos amid the chaos of the external world, the presence of mathematics and its manifold service, both as instrument and as norm, illustrate and confirm the Kantian and Riemannian conception of natural science as "the attempt to understand nature by means of exact concepts."

In connection with this division of his subject, our speaker will find it easy to enter more deeply into the spirit and marrow of it. He will be able to make it clear that there is a sense, a just and important sense, in which all thinkers and especially students of natural science, though their thinking is for the most part not rigorous, are yet themselves contributors to mathematics. I do not refer to the powerful stimulation of mathematics by natural science in furnishing it with many of its problems and in constantly seeking its aid. What I mean is that all thinkers and especially students of natural science are engaged, both consciously and unconsciously, both intentionally and unintentionally, in the mathematicization of concepts—that is to say, in so transforming and refining concepts as to fit them finally for the amenities of logic and the austerities of rigorous thinking. We are dealing here, our speaker

will say, with a process transcending conscious design. We are dealing with a process deep in the nature and being of the psychic world. Like a child, an idea, once it is born, once it has come into the realm of spiritual light, possibly long before such birth, enters upon a career, a career, however, that, unlike the child's, seems to be immortal. In most cases and probably in all, an idea, on entering the world of consciousness, is vague, nebulous, formless, not at once betraying either what it is or what it is destined to become. Ideas, however, are under an impulse and law of amelioration. The path of their upward striving and evolution—often a long and winding way—leads towards precision and perfection of form. The goal is mathematics. Witness, for example, our lecturer will say, the age-long travail and aspiration of the great concept now known as mathematical continuity, a concept whose inner structure is even now known and understood only of mathematicians, though the ancient Greeks helped in moulding its form and though it has long been, if somewhat blindly, yet constantly employed in natural science as when a physicist, for example, or an astronomer uses such numbers as e and π in computation. Witness, again, how that supreme concept of mathematics, the concept of function, has struggled through thousands of years to win at length its present precision of form out of the nebulous sense, which all minds have, of the mere dependence of things on other things. Witness, too, he will say, the mathematical concept of infinity, which prior to a half-century ago was still too vague for logical discourse, though from remotest antiquity the great idea has played a conspicuous rôle, mainly emotional, in theology, philosophy and science. Like examples abound, showing that one of the most impressive and significant phenomena in the life of the psychic world, if we will but discern and contemplate it, is the process by which ideas advance, often slowly indeed but surely, from their initial condition of formlessness and indetermination to the mathematical estate. The chemicization of biology, the physicization of chemistry, the mechanicization of physics, the mathematicization of mechanics, these well-known tendencies and drifts in science do but illustrate on a large scale the ubiquitous process in question.

At length, ladies and gentlemen, our speaker will say, in the light of the last consideration the deeper and larger aspects of our subject are beginning to show themselves and there is dawning upon us a wonderful vision. The nature, function and life of the entire conceptual world seem to come within the circle and scope of our present enterprise. We are beginning to see that to challenge the human worth of mathematics, to challenge the worth of rigorous thinking, is to challenge the worth of all thinking, for now we see that mathematics is but the ideal to which all thinking, by an inevitable process and law of the human spirit, constantly aspires. We see that to challenge the worth of that ideal is to arraign before the bar of values what seems the deepest process and inmost law of the universe of thought. Indeed we see that in defending mathematics we are really defending a cause yet more momentous, the whole cause, namely, of the conceptual procedure of science and the conceptual activity of the human mind, for mathematics is nothing but such conceptual procedure and activity come to its maturity, purity and perfection.

Now, ladies and gentlemen, our lecturer will say, I can not in this course deal explicitly and fully with this larger issue. But, he will say, we are living in a day when that issue has been raised; we happen

to be living in a time when, under the brilliant and effective leadership of such thinkers as Professor Bergson and the late Professor James, the method of concepts, the method of intellect, the method of science, is being powerfully assailed; and, whilst I heartily welcome this attack of criticism as causing scientific men to reflect more deeply on the method of science, as exhibiting more clearly the inherent limitations of the method, and as showing that life is so rich as to have many precious interests and the world much truth beyond the reach of that method, yet I can not refrain, he will say, from attempting to point out rather carefully what seems to me a radical error of the critics, a fundamental error of theirs, in respect to what is the highest function of conception and in respect to what is the real aim and ideal of the life of intellect. For we shall thus be led to a deeper view of our subject proper.

These critics find, as all of us find, that what we call mind or our minds are, in some mysterious way, functionally connected with certain living organisms known as human bodies; they find that these living bodies are constantly immersed in a universe of matter and motion in which they are continually pushed and pulled, heated and cooled, buffeted and jostled about—a universe that, according to James, would, in the absence of concepts, reveal itself as "a big blooming buzzing confusion"—though it is hard to see how such a revelation could happen to any one devoid of the concept "confusion," but let that pass; they find that our minds get into some initial sort of knowing connection with that external blooming confusion through what they call the sensibility of our bodies, yielding all manner of sensations as of weights, pressures, pushes and pulls, of intensities and extensities of brightness, sound, time, colors, space, odors, tastes, and so on; they find that we must, on pain of organic extinction, take some account of these elements of the material world; they find that, as a fact, we human beings constantly deal with these elements through the instrumentality of concepts; they find that the effectiveness of our dealing with the material world is precisely due to our dealing with it conceptually: they infer that, therefore, dealing with matter is exactly what concepts are for, saying with Ostwald, for example, that the goal of natural science, the goal of the conceptual method of mind, "is the domination of nature by man;" not only, our speaker will say, do our critics find that we deal with the material world conceptually, and effectively because conceptually, but they find also that life has interests and the world values not accessible to the conceptual method, and as this method is the method of the intellect, they conclude, not only that the intellect can not grasp life, but that the aim and ideal of intellect is the understanding and subjugation of matter, saying with Professor Bergson "that our intellect is intended to think matter," "that our concepts have been formed on the model of solids," "that the essential function of our intellect . . . is to be a light for our conduct, to make ready for our action on things," that "the intellect is characterized by a natural inability to understand life," that "intellect always behaves as if it were fascinated by the contemplation of inert matter," that "intelligence . . . aims at a practically useful end," that "the intellect is never quite at its ease, . . . except when it is working upon inert matter, more particularly upon solids," and much more to the same effect.

Now, ladies and gentlemen, our speaker will ask, what are we to think of this? What are we to think of this valuation of the science-making method of concepts? What are we to think of the aim and ideal

here ascribed to the intellect and of the station assigned it among the faculties of the human mind? In the first place, he will say, it ought to be evident to the critics themselves, and evident to them even in what they esteem the poor light of intellect, that the above-sketched movement of their minds is a logically unsound movement. They do not indeed contend that, because a living being in order to live must deal with the material world, it must, therefore, do so by means of concepts. The lower animals have taught them better. But neither does it follow that, because certain bipeds in dealing with the material world deal with it conceptually, the essential function of concepts is just to deal with matter. Nor does such an inference respecting the essential function of concepts follow from the fact that the superior effectiveness of man's dealing with the physical world is due to his dealing with it conceptually. For it is obviously conceivable and supposable that such conceptual dealing with matter is only an incident or byplay or subordinate interest in the career of concepts. It is conceivably possible that such employment is only an avocation, more or less serious indeed and more or less advantageous, yet an avocation, and not the vocation, of intellect. Is it not evidently possible to go even further? Is it not logically possible to admit or to contend that, inasmuch as the human intellect is functionally attached to a living body which is itself plunged in a physical universe, it is absolutely necessary for the intellect to concern itself with matter in order to preserve, not indeed the animal life of man, but his intellectual life—is it not allowable, he will say, to admit or to maintain *that* and at the same time to deny that such concernment with matter is the intellect's chief or essential function and that the subjugation of matter is its ideal and aim?

Of course, our lecturer will say, our critics might be wrong in their logic and right in their opinion, just as they might be wrong in their opinion and right in their logic, for opinion is often a matter, not of logic or proof, but of temperament, taste and insight. But, he will say, if the issue as to the chief function of concepts and the ideal of the intellect is to be decided in accordance with temperament, taste and insight, then there is room for exercise of the preferential faculty, and alternatives far superior to the choice of our critics are easy enough to find. It may accord better with our insight and taste to agree with Aristotle that "It is owing," not to the necessity of maintaining animal life or the desire of subjugating matter, but "it is owing to their *wonder* that men both now begin and at first began to philosophize; they *wondered* originally at the obvious difficulties, then advanced little by little and stated the difficulties about the greater matters." The striking contrast of this with the deliverances of Bergson is not surprising, for Aristotle was a pupil of Plato and the doctrine of Bergson is that of Plato completely inverted. It may accord better with our insight and taste to agree with the great C. G. I. Jacobi, who, when he had been reproached by Fourier for not devoting his splendid genius to physical investigations, replied that a philosopher like his critic "ought to know that the unique end of science is," not public utility and applications to natural phenomena, but "is the honor of the human spirit." It may accord better with our temperament and insight to agree with the sentiment of Diotima: "I am persuaded that all men do all things, and the better they are the better they do them, in the hope," not of subjugating matter, but "in the hope of

the glorious fame of immortal virtue."

But it is unnecessary, ladies and gentlemen, it is unnecessary, our speaker will say, to bring the issue to final trial in the court of temperaments and tastes. We should have there a too easy victory. The critics are psychologists, some of them eminent psychologists. Let the issue be tried in the court of psychology, for it is there that of right it belongs. They know the fundamental and relevant facts. What is the verdict according to these? The critics know the experiments that have led to and confirmed the psychological law of Weber and Fechner and the doctrine of thresholds; they know that, in accordance with that doctrine and that law, an appropriate stimulus, no matter what the department of sense, may be finite in amount and yet too small, or finite and yet too large, to yield a sensation; they know that the difference between two stimuli appropriate to a given sense department, no matter what department, may be a finite difference and yet too small for sensibility to detect, or to work a change of sensation; they ought to know, though they seem not to have recognized, much less to have weighed, the fact that, owing to the presence of thresholds, the greatest number of distinct sensations possible in any department of sense is a *finite* number; they ought to know that the number of different departments of sense is also a *finite* number; they ought to know that, therefore, the total number of distinct or different *sensations* of which a human being is capable is a *finite* number; they ought to know, though they seem not to have recognized the fact, that, on the other hand, the world of *concepts* is of *infinite* multiplicity, that concepts, the fruit of intellect, as distinguished from sensations, the fruit of sensibility, are *infinite* in number; they ought, therefore, to see, our speaker will say, though none of them has seen, that in attemping to derive intellect out of sensibility, in attempting to show that (as James says) "concepts flow out of percepts," they are confronted with the problem of bridging the immeasurable gulf between the finite and the infinite, of showing, that is, how an infinite multiplicity can arise from one that is finite. But even if they solved that apparently insoluble problem, they would not yet be in position to affirm that the function of intellect and its concepts is, like that of sensibility, just the function of dealing with matter, as the function of teeth is biting and chewing. Far from it.

Let us have another look, the lecturer will say, at the psychological facts of the case. Owing to the presence of thresholds in every department of sense it may happen and indeed it does happen constantly, in every department, that three different amounts of stimulus of a same kind give *three sensations such that two of them are each indistinguishable from the third and yet are distinguishable from one another.* Now, for sensibility in any department of sense, two magnitudes of stimulus are unequal or are equal according as the sensations given by them are or are not distinguishable. Accordingly in the world of sensible magnitudes, in the sensible universe, in the world, that is, of *felt* weights and thrusts and pulls and pressures, of *felt* brightnesses and warmths and lengths and breadths and thicknesses and so on, in this world, which is the world of matter, *magnitudes are such that two of them may each be equal to a third without being equal to one another.* That, our speaker will say, is a most significant fact and it means that the sensible world, the world of matter, is irrational, infected with contradiction, contravening the essential laws of thought. No wonder, he will say, that old

Heraclitus declared the unaided senses "give a fraud and a lie."

Now, our speaker will ask, what has been and is the behavior of intellect in the presence of such contradiction? Observe, he will say, that it is intellect, and not sensibility, that detects the contradiction. Of the irrationality in question sensibility remains insensible. The data among which the contradiction subsists are indeed rooted in the sensible world, they inhere in the world of matter, but the contradiction itself is known only to the logical faculty called intellect. Observe also, he will say, and the observation is important, that such contradictions do not compel the intellect to any activity whatever intended to preserve the life of the living organism to which the intellect is functionally attached. That is a lesson we have from our physical kin, the beasts. What, then, *has* the intellect done because of or about the contradiction? Has it gone on all these centuries, as our critics would have us believe, trying to "think matter," as if it did not know that matter, being irrational, is not thinkable? Far from it, he will say, the intellect is no such ass.

What it has done, instead of endlessly and stupidly besieging the illogical world of sensible magnitudes with the machinery of logic, what it has done, our lecturer will say, is this: it has created for itself another world. It has not rationalized the world of sensible magnitudes. That, it knows, can not be done. It has discerned the ineradicable contradictions inherent in them, and by means of its creative power of conception it has made a new world, a world of conceptual magnitudes that, like the continua of mathematics, are so constructed by the spiritual architect and so endowed by it as to be free alike from the contradictions of the sensible world and from all thresholds that could give them birth. Indeed conception, to speak metaphorically in terms borrowed from the realm of sense, is a kind of infinite sensibility, transcending any finite distinction, difference or threshold, however minute or fine. And, now, our speaker will say, it is such magnitudes, magnitudes created by intellect and not those discovered by sense, though the two varieties are frequently not discriminated by their names, it is such conceptual magnitudes that constitute the subject-matter of science. If the magnitudes of science, apart from their rationality, often bear in conformation a kind of close resemblance to the magnitudes of sense, what is the meaning of the fact? It means, contrary to the view of Bergson but in accord with that of Poincaré, that the free creative artist, intellect, though it is not constrained, yet has chosen to be guided, in so far as its task allows, by facts of sense. Thus we have, for one example among many, conceptual space and sensible space so much alike in conformation that, though one of them is rational and the other is not, the undiscriminating hold them as the same.

And now, our lecturer will ask, for we are nearing the goal, what then *is* the motive and aim of this creative activity of the intellect? Evidently it is not to preserve and promote the life of the human body, for animals flourish without the aid of concepts and despite the contradictions in the world of sense. The aim is, he will say, to preserve and to promote the life of the intellect itself. In a realm infected with irrationality, with omnipresent contradictions of the laws of thought, intellect can not live, much less flourish; in the world of sense, it has no proper subject-matter, no home, no life. To live, to flourish, it must be able to think, to think in accordance with the laws of its being. It is stimulated and its activity sustained by two opposite

forces: discord and concord. By the one it is driven; by the other, drawn. Intellect is a perpetual suitor. The object of the suit is not the conquest of matter, it is a thing of mind, it is the music of the spirit, it is Harmonia, the beautiful daughter of the muses. The aim, the ideal, the beatitude of intellect is harmony. That is the meaning of its endless talk about compatibilities, consistencies and concords, and that is the meaning of its endless battling and circumvention and transcendence of contradiction. But what of the applications of science and public service? These are by-products of the intellect's aim and of the pursuit of its ideal. Many things it regards as worthy, high and holy—applications of science, public service, the "wonder" of Aristotle, Jacobi's "honor of the human spirit," Diotima's "glorious fame of immortal virtue"—but that which, by the law of its being, intellect seeks above all and perpetually pursues and loves, is harmony. It is for a home and a dwelling with her that intellect creates a world; and its admonition is: Seek ye first the Kingdom of Harmony, and all these things shall be added unto you.

And the ideal and admonition, thus revealed in the light of analysis, are justified of history. Inverting the order of time, we have only to contemplate the great periods in the intellectual life of Paris, Florence and Athens. If, among these mightiest contributors to the spiritual wealth of man, Athens is supreme, she is also supreme in her devotion to the intellect's ideal. It is of Athens that Euripides sings:

The sons of Erectheus, the olden,
  Whom high gods planted of yore
In an old land of heaven upholden,
  A proud land untrodden of war;
They are hungered, and lo, their desire
  With wisdom is fed as with meat;
In their skies is a shining of fire,
  A joy in the fall of their feet;
And thither with manifold dowers,
  From the north, from the hills, from the morn,
The Muses did gather their powers,
  That a child of the Nine should be born;
And Harmony, sown as the flowers,
  Grew gold in the acres of corn.[2]

And thus, ladies and gentlemen, our lecturer will say, what I wish you to see here is, that Science, and especially Mathematics, the ideal form of science, are creations of Intellect in its quest for Harmony. It is as such creations that they are to be judged and their human worth appraised. Of the applications of mathematics to engineering and of its service in natural science, I have spoken at length, he will say, in the course of previous lectures. Other great themes of our subject remain for consideration. To appraise the worth of mathematics as a discipline in the art of rigorous thinking and as a means of giving wing to the subtler imagination; to estimate and explain its value as a norm for criticism and for guidance of speculation and pioneering in fields not yet brought under the dominion of logic; to estimate its esthetic worth as showing forth in psychic light the law and order of the psychic world; to evaluate its ethical significance in rebuking by its certitude and eternality the facile skepticism that doubts all knowledge, and especially in serving as a retreat for the spirit when as at times the world of sense seems madly bent on heaping strange misfortunes up and "to and fro the chances of the years dance like an idiot in the wind"; to give a sense of its religious value in "the contemplation of ideas under the form of eternity," in disclosing a cosmos of perfect beauty and everlasting order and in presenting there, for meditation, endless consequences traversing the rational world and seeming to point to a mystical region above and beyond: these and similar themes, our speaker

[2] Translation by Professor Gilbert Murray.

will say, remain to be dealt with in subsequent lectures of the course.

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CHEMISTRY AS AFFECTING THE PROFITABLENESS OF INDUSTRY[1]

In beginning the preparation of this paper I had thought of considering chemical industry as if it were distinct from other industries, but, as the subject developed, it became very apparent that no such distinct line could be drawn. Properly speaking, all industries must be considered as chemical. It is next to impossible to imagine the existence of an industry in which chemical reactions or considerations, either directly or indirectly, do not enter. It is possible that we could define chemical industry in a somewhat restricted sense, but such a definition would hardly be other than arbitrary. The lines of demarcation would be indistinct and shadowy. The only basis for such a definition would be the attitude of the popular mind. This attitude of mind has been steadily growing towards the recognition that chemistry is an important factor in every industry, and when, in any particular case, it becomes popularly recognized that chemistry is a factor in an industry, then that industry becomes a chemical industry. Ultimately, this popular recognition will extend to all industries and the rapidity of the growth of such recognition indicates that the time is not far distant when all industries will be generally and popularly recognized as chemical.

My plan had been to discuss the profitableness of chemical industry, but if we accept this conception that all industries are chemical, it would seem better that our discussion should be broadened so as to consider the general effect of chemistry upon the profitableness of industrial operations, using the words "industrial operations" as including all phases of the actual production of wealth.

Perhaps it would be well that I should make clear the conception that all industries are chemical in one or more phases. By way of illustration, let us consider the relation of chemistry to the production of power. I think we can show that there is a very close connection between chemistry and such production, and also that there is no industry which does not depend upon the consumption of power, and if this is the case, it becomes very evident that, from the power standpoint alone, all industries are chemical industries.

Our first impressions of power are those which we ourselves are conscious of exercising, and, in practise, the simplest form of power is man power as manifested in manual labor. It is not customary, perhaps, except from the humanitarian standpoint, to consider the chemical changes in the human body, converting food into work, as factors in industry. Nevertheless, they deserve serious consideration. It is being learned daily that properly fed employees are more efficient as workmen, and the study of food problems is surely a phase of the application of chemistry to industry. In some industries, the study of the food consumed by employees has a direct bearing upon the health of the employees as affected by the industry. It is found that certain foods act as prophylactics towards certain industrial diseases, and that other foods (perhaps improperly so called) act in the opposite manner. The scientific study of foods in connection with efficient manual labor is a phase of welfare work that has not been considered to the extent it deserves. Take, on the other hand, the horse. It is true that the horse is being

[1] Chairman's address, N. Y. Section—Society of Chemical Industry, October 17, 1913.

displaced by the locomotive and automobile, and as a power factor has been almost completely superseded by mechanical appliances; still, so far as the horse is used for the power he furnishes, his proper feeding is a phase of the application of chemistry to industry. Perhaps, it may be considered that these two illustrations, the feeding of employees and the feeding of horses, are trivial as compared with the study of the production of power through the use of the steam boiler, the steam engine, the gas producer, and the internal combustion engine. Probably this is so, for, in the production of power by these mechanical means, we have clearly recognized chemical reactions, and the understanding of these chemical reactions is essential to the proper economy of fuel and the production of power with the least outlay. In these cases, chemistry teaches us the need of a proper balancing of the combustible material used and the air supply, so that the loss of heat in effluent gases may be reduced to a minimum. In the steam boiler, chemistry has taught much of great value in relation to the refractory materials used, the utility of water consumed, and how to correct its scale-forming tendencies. In recent years, numerous excellent devices have been developed for automatically giving information as to the composition of flue gases, with the result that great savings in the cost of power have been made. The study of the composition of coals has resulted in a better classification of coals, a truer connection between price and quality, and the purchase of coals by specifications involving chemical examination is becoming more extensive each year. The small power plant can not perhaps give as much attention to chemical factors as a large plant can, but in large power plants, the economy resulting from the study of the chemistry of combustion has enabled such plants to furnish power to outsiders with a profit to themselves and to those to whom they sell it. It was chemical considerations that led to the use of blast furnace gases in the gas engine for the production of power; and if the chemist's dream comes true, there will come a time when power will be more directly produced from coal than it is to-day. It is, of course, recognized that in the utilization of the energy in our great waterfalls, chemistry is an unimportant factor, but here there is the compensating fact that many of our great chemical industries have been dependent for their existence and growth upon the cheap power thus produced.

This is as far as our time permits us to speak of the influence of chemistry upon the production of power. The scope of this paper will not allow a more detailed treatment of this subject, and what we have said is more as a matter of obvious illustration of one point of the dependence of the profitableness of industry in general upon chemical factors. If we have made this point clear, we will proceed to recount other phases of the relation of chemistry to industry.

The simplest phase is undoubtedly that which relates to the purely commercial end of industry, wherein goods are bought and sold subject to analysis, the analysis being presumed to indicate the commercial value of the goods. These goods may be in the raw state, partially finished, or finished and ready for consumption. The oldest form of this kind of analytical control was undoubtedly for the valuation of precious metals and the ores containing them. The accuracy with which gold and silver can be determined by fire assay was recognized in the early stages of metallurgical development. The fire assay corresponded on a small scale to the actual

recovery of gold and silver in smelting operations. It was natural, therefore, to assume that a similar correspondence existed between the fire assay of other metalliferous substances and the smelting operations then practised. What could be done with gold and silver, however, could not be done with the same accuracy with the more readily oxidized metals, and while the fire assay method is still applied in some places to metals other than gold and silver, in general these methods have been superseded by wet methods, which are more obviously chemical in their character, and of greater accuracy.

The chemical testing of commodities sold under specifications is primarily for the purpose of protecting the purchaser, although accuracy of testing is necessary in order that justice may be done to the seller. Practically all raw materials dealt in in quantity are sold subject to chemical analysis. Chemical analysis may not be specified in the sale or made use of by the purchaser, but, in some form or other, the purchaser has the right to test out the products received, to see whether the terms of the sale have been lived up to. Very few commodities are sold to-day in regard to which there is not some recorded information on which a purchaser can base claims, if chemical analysis shows these commodities to be different from those described in the order or contract.

If we consider, however, the whole question of the purchase of commodities on either tacit or openly acknowledged chemical requirements, we will see that chemistry has had a great influence in determining the profitableness of industry, in preventing the delivery of inferior raw or semiraw materials, which would ultimately affect the yield or quality of the finished product. The whole operation of our pure food and pure commodity laws depends upon the availability of chemical analysis and testing, and it is only natural that the rapid growth of sentiment in favor of these laws should have produced some commercial hardships, which have led to the criticism of chemical control and standards as being too rigid and unsuited to popular requirements. Nevertheless, such pure commodity laws have been of great profit to the purchasing public.

But if chemistry has had a great influence upon the profitableness of industry in the purchasing of commodities, what shall we say as to its effect on the profitableness of industry in the sale of commodities? In the popular mind, profits are made on sales, not on purchases, and the salesman seems to be, to use the language of the streets, "the whole thing." Most businesses are dominated by the salesman, be he proprietor, manager, or drummer. According to this idea, in the making of profit, the salesman is a factor greater than the purchasing agent, or even the manager of the manufacturing department, considering that these are distinct from each other. There is undoubtedly a great deal of truth in this conception, and the popular idea rests on fairly well established facts. Taking this to be the case, what has been the influence of chemistry on the sale of commodities as affecting business profits? It is generally admitted that the old-fashioned personal influence of the salesman over the sale of his goods is growing less year by year. In place of this old-fashioned personal influence is coming a newer influence in which the salesman secures his sales, not by debauching the purchaser, but by his intelligence and the helpful knowledge which he possesses about the goods he sells, and, we must add, the confidence which the purchaser has in the salesman because of his possessing that knowledge. It is no longer the general practise to keep sales-

men ignorant of processes of manufacture and use, but salesmen are being educated in many cases by technical men, often chemists, on the merits of their goods and how they may properly meet complaints. Then, too, the chemist's influence in improving the quality of products assists the salesman by giving him more saleable products. I can not take more than passing and regretful notice of the fact that there are some few chemists whose occupation appears to be mostly that of showing how goods may be debased without easy detection. The influence of the chemist in improving the quality of goods shows itself in the increased price which may be obtained for such goods. Perhaps, also, we should mention the general effect upon the commercial atmosphere of a business that has trained chemists in its employ, who give confidence to the general public that its products are made as well as can be with the assistance of the best that science can give.

Coming now to actual manufacturing operations, we will consider what the chemist has done in controlling manufacturing processes, correcting losses in manufacture, assisting in the invention of new methods and in the development of new uses for regular products, waste products and by-products. Work along this line is particularly attractive to the chemist, and, in some cases, can only be conducted profitably by the chemist. The extent to which chemical knowledge is necessary or desirable can, of course, be determined only by considering each case by itself. There are, in every case, practical limitations, in regard to which the chemist should be reasonable. Simply because, in general, chemistry is helpful, it must not, therefore, be assumed that in every case the chemist can increase the profitableness of manufacturing operations, because it must be remembered that the chemist is worthy of his hire, and that hire may more than absorb the value of what he may accomplish. In the control of manufacturing processes, if uniformity of product is desired, there is probably no one better qualified than the chemist to establish such control. This he will accomplish by the systematic study of all the materials entering into the process and the product in all stages of manufacture, discovering the chemical reactions of the process, where these reactions occur, and how they can be accelerated to advantage or made more complete, if that is desirable. Considering in the abstract the manufacturing operation involving a consumption of raw materials, heat, power, and labor, the fundamental units of cost are the time consumed and the quantity of product made. The chemist should possess an analytical mind, and, in the study of a manufacturing process, he will endeavor to develop the effect of these fundamental factors and seek to control the other cost factors, keeping in mind the preservation of the full value of the chemical reactions taking place. Chemistry has been a great help and profit to industry in the control of manufacturing losses, and the business man who fails to recognize its value can not be considered as practical. For the avoidance of such losses, the chemist is peculiarly fitted. Some industries, it is true, can be conducted profitably with large losses of some of the constituents contained in the raw materials, but, in the course of time, these losses must be controlled, for the industry that applies the best control will be the most profitable and the best able to withstand competition. This can be done only by systematic chemical examination of the materials used and by systematic study of the chemical reactions entering into the processes. But the work that chemistry does in preventing losses in manufacture is

not merely the direct prevention of such losses. Chemistry impresses itself sooner or later upon the manufacturer if he is awake, even though he be not technically trained, and he realizes that his manufacturing operations are not shrouded in mystery. The question of yield comes under the law of the conservation of matter. Matter does not disappear without going somewhere, and if it does disappear, it has been stolen, or some mistake has been made in accounting, or the matter has been changed in form, or actually lost in some of the refuse products. This is an exceedingly important subject. Many untechnical men think that yield, as they would express it, is "purely a practical question" and that losses in manufacture, like taxes and death, are something that we can not get away from. The chemist valiantly attacks this belief. He asserts that losses occur for material reasons. This attitude of the chemist is simply a rational attitude which increases very materially the profitableness of industry. In developing new uses for regular products, waste products, and by-products, the chemist has left his indelible mark upon industry. Here he is in the lead, and his constructive mind is not satisfied with announcing his immediate discoveries, but in pointing the way to the rich fields of possible discovery that lie before him.

It is proper here to elaborate a little on the value of chemical societies and their journals. Chemical societies, seeking at all times to bring out the most recent information bearing on chemical problems, obtain numerous papers, which, published in their journals, are available, in most of our large public libraries, to business men whether technically educated or not. Frequently, the information which they may want is obtained in complete form in these journals. In other cases, the information has to be interpreted by chemists, and in still other cases the information is so distantly connected with the problems involved as to be available only to chemists who open up vast possibilities of profit to industry. It is hardly to be expected that the chemist will be acquainted with all the published facts relating to any problem, but if he knows where these facts may be obtained, and if he knows how to interpret them, they soon become available, no matter how long they may have remained buried in the literature of the subject. The application of such facts frequently develops new ones, which in their turn may have high potential value. So valuable are these chemical records that I must not lose this opportunity of pointing to the great service chemists are doing and to urge them to enlarge this service to the greatest practicable degree by further contributions. The knowledge which we may possess is of value to us individually, but in the general service of mankind we can frequently impart some of this knowledge, without hurting ourselves, at the same time extending a helping hand to others.

Much has been written upon the influence of the research chemical laboratory on the profitableness of industry. Valuable information is on record showing how, in numerous cases, the research laboratory has been a tremendous profit to industry. In some cases the research laboratory is devoted almost entirely to the development of new processes and products, and it would appear that the Germans have most successfully applied this method, and that their commercial high standing in chemical manufacture has been more due to this than to any superiority in methods or economies in manufacturing. While this is true, it appears to the writer that the research laboratory has another function not usually recognized. If I were to try to

define this function of the research laboratory in popular language, I would say that it keeps the industry "ahead in the game." It is not only in the concrete things which the research laboratory does that its profitableness is to be measured, but its real value is also in the general advance work that it does. It gives to an industry a proper understanding of the needs of the trade. The industry that does not keep itself informed as to these needs is sure to lag behind. The fundamental information as to the needs of the trade can only be furnished by the chemist who has studied the possibilities, theoretical and practical, of both processes and products. The research laboratory is destroying trade superstitions, which have hindered progress. It has furnished information to salesmen which they have been able to use to practical advantage. It has been in many respects the reflective organ of industry. The research laboratory could not have been any of these things if it were not continuously studying the problem presented directly and indirectly to it and availing itself of the invaluable records preserved in our chemical journals.

In those industries involving the manufacture of chemicals or in which chemistry is a predominating and obvious influence, the chemist is, of course, appreciated, although there are many such industries which do not utilize the chemist as fully and as completely as would be to their advantage. The really successful and profitable chemical manufacturing industries avail themselves of the services of the best chemists obtainable.

The indirect influence of chemistry upon the profitableness of industry should not be overlooked. The philosopher who once said something to the effect that the man who made two blades of grass grow where only one grew before is a public benefactor, stated a truth that applies with a special force to the chemist. The discoveries of chemistry which have been of no direct value to the discoverer, but have been of great indirect value to humanity, are innumerable. Sometimes a chemist is looked upon with scorn because he has not made personal profit out of his discoveries, which he has published to the world and made common property. This form of communism is idealistic. The discoveries of Pasteur have added immense profit to the fermentation industries and have been the saving of innumerable lives. I know of no class which contributes, as chemists do, so freely to the fund of general knowledge on which profitable business is based. Then, too, there is the indirect saving which the chemist is responsible for in the conservation and utilization of industrial products. The studies relating to the corrosion of iron and steel and indeed to all of the phenomena of decay have resulted in greater permanence and durability of the products of industry, the benefits of which all industries may share.

In arguing, as we have, in favor of the proposition that chemistry is a powerful factor in making industry profitable, we must not close our eyes to its limitations. The chemist should be a business man in the best sense of the words, and should recognize that in all successful business operations a proper balancing and coordination of all its factors is necessary. The study of power problems should be made, but the extent to which expenditure for the study of power factors should be made depends upon the importance of the power factor. The testing of materials purchased and used should be made, but the extent to which such testing should be made can only be determined by the proper consideration of its relative importance. New processes and products should be developed, but

there is a limit to expenditure for these ends, which limit is in the hope of profit to be derived. After all, all industry depends upon the production or exchange of articles that are desirable, and the desirability of an article is a determining factor in its value. But not merely must a product be desirable, it must be produced with proper economy, for that is a limiting factor affecting its marketability.

We have discussed this subject in an abstract manner. Many illustrations could have been introduced of how industries have profited through the assistance of chemistry. We have thought it better, however, to omit such illustrations but hope that during the coming year we shall have many papers practically demonstrating that what we have presented in the abstract is concretely true. When we speak of chemistry as affecting the profitableness of industry, we must bear in mind that, while all chemical knowledge may be said to come from the chemist, such knowledge is often made use of with profit by those who are not chemists. This is something that is unavoidable, and it seems to me no attempt should be made to make it avoidable. The benefits which chemists derive from the more general diffusion of chemical knowledge are very much greater than would be the case if chemists were successful in an attempt to make their profession esoteric. The progress of humanity can not be accomplished by making the study of chemistry and the benefits that come from it profitable only to the chemist. It is proper that the chemist should seek to obtain profit from his knowledge and ability, but he can not hope to do this except in some few cases, unless he is willing to give to others at least a portion of the knowledge that he possesses. All industries and occupations are interdependent. All industry depends upon the chemist, and the chemist depends upon all industry. The more this interdependence is recognized, the greater the profit accruing to industry, and the greater the return to the chemist.

G. W. Thompson

INTERNATIONAL CONFERENCE ON THE STRUCTURE OF MATTER[1]

The first International Conference in Brussels on the Theory of Radiation in 1911 owed its inception to Mr. Ernest Solvay, and proved a great success. Shortly afterwards, Mr. Solvay generously gave the sum of one million francs to form an International Physical Institute (*Nature*, Vol. XC., p. 545), part of the proceeds to be devoted to assistance of researches in physics and chemistry, and part to defray the expenditure of an occasional scientific conference between men of all nations to discuss scientific problems of special interest. In pursuance of this aim the second International Conference or Conseil International de Physique Solvay, was held in Brussels this year on October 27–31, under the able presidency of Professor Lorentz. On this occasion the general subjects of discussion were confined to the structure of the atom, the structure of crystals, and the molecular theory of solid bodies.

Reports were presented by the following: The structure of the atom, Sir J. J. Thomson; Interferenzerscheinungen an Röntgenstrahlen hervorgerufen durch das Raumgitter der Kristalle, Professor Laue; the relation between crystalline structure and chemical constitution, W. Barlow and Professor Pope; some considerations on the structure of crystals, Professor Brillouin, and Molekulartheorie der Festen Korper, Professor Gruneisen.

Among those present at the meeting were Professors Lorentz, Kamerlingh Onnes, Sir J. J. Thomson, Barlow, Pope, Jeans, Bragg, Rutherford, Mme. Curie, Gouy, Brillouin, Langevin, Voigt, Warburg, Nernst, Rubens, Wien, Einstein, Laue, Sommerfeld, Gruneisen, Weiss, Knudsen, Hasenöhrl, Wood, Goldschmidt, Verschaffelt, Lindemann and De Broglie.

[1] From *Nature*.

An interesting and vigorous discussion followed on all the papers presented to the congress. Special interest was taken in the report of Laue on the interference phenomena observed in crystals with X-rays. A valuable contribution was made by Professor Bragg on selective reflection of X-rays by crystals, and on the information afforded by this new method of research on crystalline structure. The report of Mr. Barlow and Professor Pope on the relation between crystalline structure and chemical constitution was illustrated by a number of models, and was followed with much interest. A report on the papers and discussions at the conference will be published as promptly as possible.

The arrangements for the meeting, which was successful in every way, were admirably made by Dr. Goldschmidt. All the members stayed at the same hotel, and thus were afforded the best of opportunities for social intercourse and for the interchange of views on scientific questions. During the meeting, the members were very hospitably entertained by Mr. Solvay and Dr. Goldschmidt, while a visit was made to the splendid private wireless station of the latter, which is one of the largest in the world, capable of transmitting messages to the Congo and Burmah.

The committee of the International Physical Institute, who were present at the conference, held meetings to consider the applications for grants in aid of research, made possible by the sum set aside for this purpose by Mr. Solvay at the foundation of the institute.

It was arranged that the next meeting of the Conseil de Physique should be held in three years' time at Brussels, when there will be a new program of subjects for discussion. In order to extend the scope of the congress, and to make it as representative as possible, it has been arranged that the original members will retire automatically at intervals, while their place will be taken by new members, who will be specially invited to take part in discussion of definite scientific topics.

E. Rutherford

THE GEOLOGICAL SOCIETY OF AMERICA

The twenty-sixth annual meeting of the Geological Society of America will be held in Princeton, N. J., on December 30, 1913, to January 1, 1914, inclusive. The sessions of the Society will be held in Guyot Hall and the council is going to continue the plans adopted for the management of last winter's meeting. The morning sessions will be devoted to papers that promise to be of general interest; the noon recess will be long in order to give some time for social intercourse, group discussions and the examination of special exhibits; the afternoon sessions will be somewhat short and will be given over to sectional meetings and to papers of less general scope. A special room (or more than one, if needed) will be provided for the display of specimens, the hanging of charts not needed in the public reading of papers, and for similar purposes. The smoking and general conversation room or rooms will be independent of the foregoing.

The annual address of the retiring president, Professor E. A. Smith, will be delivered on the evening of Tuesday the 30th. Dr. Arthur L. Day, director of the Carnegie Institution's geophysical laboratory has consented to give an illustrated lecture on "Kilauea During the Year 1912," which was the most active period of the volcano within historic times. Dr. Day will include in his address a statement of the results of the work done at the geophysical laboratory on the gases and other material collected at Kilauea. The lecture will be given at a time to be announced later.

The council respectfully urges the fellows to consider the following points in the preparation and presentation of their papers:

1. Subjects selected for presentation should include, as far as possible, matters of general interest and wide application. Details of local problems seldom hold the attention of the audience so closely as the new aspects of general considerations which such details may exemplify.

2. The time required for presenting a paper should be not more than twenty minutes, or at the outside thirty minutes. If the speakers will carefully estimate the time actually needed

for the completion of their papers, such time will, within reasonable limits, be allowed; the speakers will then be saved from the disappointment of being interrupted before their conclusions are reached, and the officers will be relieved from the embarrassment of enforcing the rule regarding the time-limit.

3. It is particularly urged that diagrams and charts should be made on such a scale that they can be deciphered easily at a distance of 30 or 40 feet; and that lantern slides should be exhibited in moderate number, only such being chosen as directly illustrate the subject under discussion. Lantern slides should, if possible, be introduced as the points that they illustrate are reached, rather than after the conclusion of the paper.

By invitation of the fellows residing in Princeton the usual smoker or general social gathering will be held on Tuesday evening, the 30th, after the presidential address. The customary subscription dinner will take place Wednesday evening.

A valuable feature of the regular and social sessions of the annual meetings has always been the attendance of students and other junior workers in geological science, as visitors. The council desires to increase the number of such attendants, and with this object requests each fellow to send to the secretary, not later than December 10, the names and addresses of persons who, whether they can attend the meeting or not, are seriously interested in geology and deserving of recognition as visitors, although they have not yet reached such standing as to gain membership in the society. The council will then write to the persons thus nominated, inviting them to attend the Princeton meeting.

The Paleontological Society will hold its annual meeting in connection with the meeting of the Geological Society, the sessions beginning on Wednesday, December 31, 1913. Detailed information regarding this meeting may be obtained from Dr. R. S. Bassler, U. S. National Museum, Washington, D. C., Secretary of the Society.

Edmund Otis Hovey,
Secretary

THE SOCIETY OF AMERICAN BACTERIOLOGISTS

The annual meeting of the Society will be held in Montreal, December 31, 1913, and January 1 and 2, 1914 under the presidency of Professor C.-E. A. Winslow. The meetings of the society will be held in the new Medical Building of McGill University on December 31 and January 2. The society will meet at Macdonald College on January 1, leaving Montreal at 9:10 A.M., and returning at 5:42 P.M. Luncheon will be served to the members at Macdonald College.

The annual dinner will be held at the University Club on the evening of January 1. The president's address "The Characterization and Classification of Bacterial Types" will follow the dinner.

The program is divided into topics each of which will occupy one session of the meeting. Titles of papers should be in the hands of the Program Committee not later than November 20, 1913.

Soil Bacteriology—Otto Rahn, University of Illinois, Urbana, Illinois.

Sanitary Bacteriology—including Water and Dairy Bacteriology—H. W. Hill, Institute Public Health, London, Ontario, Canada.

Systematic Bacteriology—H. J. Conn, Geneva, New York.

Technic—L. A. Rogers, Department of Agriculture, Washington, D. C.

Immunity—Benjamin White, Director of Hoagland Laboratory, Brooklyn, New York.

Pathology—P. F. Clark, No. 1027 N. Caroline Street, Baltimore, Md.

Typewritten abstracts of papers (not more than 300 words) should be in the hands of the secretary not later than the last session. These abstracts last year were published in Science and *Cent. f. Bakt.*

A. Parker Hitchens,
Secretary

Glenolden, Pennsylvania

THE ATLANTA MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The sixty-fifth meeting of the American Association for the Advancement of Science,

and the twelfth of the "Convocation Week" meetings, will be held in Atlanta, Georgia, from December 29, 1913, to January 3, 1914.

The council will meet Monday morning, December 29, and each following morning, in the council room, at 9 o'clock. The opening general session of the association will be held at 8 o'clock on the evening of Monday, December 29. The meeting will be called to order by the retiring president, Dr. Edward C. Pickering, who will introduce the president of the meeting, Dr. Edmund B. Wilson. After addresses of welcome by Governor John M. Slaton and Mayor James G. Woodward and a reply by President Wilson, the annual address of the retiring president, Dr. Edward C. Pickering, will be given on "The Study of the Stars." After the address there will be a reception to members of the association and affiliated societies in Taft Hall.

The sections and the affiliated societies will meet daily at 10 A.M. and 2 P.M. Each section will offer a program of general interest at one or two sessions. The sections will arrange programs of special papers only when the corresponding national society does not meet at the same time and place.

The address of the retiring chairmen of the sections will be given as follows:

MONDAY AT 2 P.M.

Vice-president Locy, before the Section of Zoology. Title: "The Story of Human Lineage."

TUESDAY AT 2 P.M.

Vice-president Van Vleck, before the Section of Mathematics and Astronomy. Title: "The Influence of Fourier's Series upon the Development of Mathematics."

Vice-president Webster, before the Section of Physics. Title: "The Methods of Physical Science: to what do they Apply?"

Vice-president Johnson, before the Section of Botany. Title: "Some Botanical Contributions to the Solution of an important Biological Problem."

WEDNESDAY AT 2 P.M.

Vice-president Cattell, before the Section of Education. Title: "Science, Education and Democracy."

THURSDAY AT 2 P.M.

Vice-president Holmes, before the Section of Mechanical Science and Engineering. Title: "Safety and the Prevention of Waste in Mining and Metallurgical Operations."

Vice-president Todd, before the Section of Geology and Geography. Title: "Pleistocene History of the Missouri River."

AT 4 P.M.

Vice-president Hammond, before the Section of Social and Economic Science. Title: "The Development of Our Foreign Trade."

FRIDAY AT 4:30 P. M.

Vice-president Macleod, before the Section of Physiology and Experimental Medicine. Title: "The Physiological Instruction of Medical Students."

There will be two public lectures, complimentary to the citizens of Atlanta and vicinity, one on Tuesday evening by Dr. Charles Wardell Stiles, of the U. S. Public Health Service, on "The Health of the Mother in the South," and one on Wednesday evening by Professor Charles E. Munroe, of the George Washington University, on "The Explosive Resources of the Confederacy during the War and Now: A Chapter in Chemical History."

It is expected that there will be a number of joint meetings and the usual smokers and dinners. The Ladies' Reception Committee will arrange functions for the women members of the association and affiliated societies and for the women accompanying members. The hotel headquarters are the Piedmont. A railroad rate of one fare and three fifths for the round trip, on the certificate plan, conditioned upon the presentation at the meeting of not less than 200 certificates, has been granted by the Trunk Line Association.

The following societies have indicated their intention to meet in Atlanta during Convocation Week in affiliation with the association:

Astronomical and Astrophysical Society of America.—Will meet on dates to be announced, including joint session with Section A. Secretary, Professor Philip Fox, Dearborn Observatory, Evanston, Ill.

Botanical Society of America.—Will meet on

Tuesday, Wednesday, Thursday and Friday, December 30 to January 2. Will hold joint sessions with Section G and American Phytopathological Association on Tuesday and Friday, respectively. Secretary, Dr. George T. Moore, Missouri Botanical Garden, St. Louis, Mo.

American Association of Economic Entomologists.—Will meet on Thursday and Friday, January 1 and 2. Secretary, Albert F. Burgess, Gipsy Moth Parasite Laboratory, Melrose Highlands, Mass.

Entomological Society of America.—Will meet on Tuesday and Wednesday, December 30 and 31. Public address on Wednesday, December 31, at 8 P.M. Secretary, Professor Alex. D. McGillivray, 603 W. Michigan Avenue, Urbana, Ill.

American Federation of Teachers of the Mathematical and the Natural Sciences.—Will meet on Tuesday, December 30. Secretary, Dr. William A. Hedrick, McKinley Manual Training School, Washington, D. C.

American Association of Official Horticultural Inspectors.—Will meet on dates to be announced. Secretary, Professor J. G. Sanders, University of Wisconsin, Madison, Wis.

American Microscopical Society.—Will meet on Tuesday and Wednesday, December 30 and 31. Joint sessions with Sections F and G on dates to be announced. Secretary, Professor T. W. Galloway, James Millikin University, Decatur, Ill.

American Physical Society.—Will meet on Tuesday, Wednesday, Thursday and Friday, December 30 to January 2, in joint sessions with Section B. Secretary, Dr. Alfred D. Cole, Ohio State University, Columbus, Ohio.

American Phytopathological Association.—Will meet on dates to be announced. Will hold joint sessions with Section G on Tuesday, December 30, and with Botanical Society of America on Friday, January 2. Secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

School Garden Association of America.—Will meet on Wednesday, December 31. Secretary, Edwin J. Brown, Dayton, Ohio.

Society of the Sigma Xi.—Will hold its convention on Tuesday, December 30. Corresponding Secretary, Professor H. B. Ward, University of Illinois, Urbana, Ill.

Southern Society for Philosophy and Psychology.—Will meet on dates to be announced, including joint sessions with Section H. Secretary, Dr. W. D. Ruediger, George Washington University, Washington, D. C.

The officers for the Atlanta meeting are as follows:

President

Edmund B. Wilson, Columbia University, New York, N. Y.

Vice-presidents

A.—*Mathematics and Astronomy*—Frank Schlesinger, Allegheny Observatory, Allegheny, Pa.

B.—*Physics*—Alfred D. Cole, Ohio State University, Columbus, Ohio.

C.—*Chemistry*—Carl L. Alsberg, Bureau of Chemistry, U. S. Department of Agriculture, Washington, D. C.

D.—*Mechanical Science and Engineering*—O. P. Hood, U. S. Bureau of Mines, Pittsburgh, Pa.

E.—*Geology and Geography*—J. S. Diller, U. S. Geological Survey, Washington, D. C.

F.—*Zoology*—Alfred G. Mayer, Carnegie Institution of Washington, Washington, D. C.

G.—*Botany*—Henry C. Cowles, University of Chicago, Chicago, Ill.

H.—*Anthropology and Psychology*—Walter B. Pillsbury, University of Michigan, Ann Arbor, Mich.

I.—*Social and Economic Science*—Judson G. Wall, Tax Commissioner, New York, N. Y.

K.—*Physiology and Experimental Medicine*—Theodore Hough, University of Virginia, Charlottesville, Va.

L.—*Education*—Philander P. Claxton, Commissioner of Education, Washington, D. C.

Permanent Secretary

L. O. Howard, Smithsonian Institution, Washington, D. C.

General Secretary

Harry W. Springsteen, Western Reserve University, Cleveland, Ohio.

Secretary of the Council

William A. Worsham, Jr., State College of Agriculture, Athens, Ga.

Secretaries of the Sections

A.—*Mathematics and Astronomy*—Forest R. Moulton, University of Chicago, Chicago, Ill.

B.—*Physics*—William J. Humphreys, U. S. Weather Bureau, Washington, D. C.

C.—*Chemistry*—John Johnston, Geophysical Laboratory, Carnegie Institution of Washington, Washington, D. C.

D.—*Mechanical Science and Engineering*—Arthur H. Blanchard, Columbia University, New York, N. Y.

E.—*Geology and Geography*—GEORGE F. KAY, State University of Iowa, Iowa City, Iowa.
F.—*Zoology*—HERBERT V. NEAL, Tufts College, Mass.
G.—*Botany*—W. J. V. OSTERHOUT, Harvard University, Cambridge, Mass.
H.—*Anthropology and Psychology*—(*Acting Secretary*), E. K. STRONG, JR., Columbia University, New York, N. Y.
I.—*Social and Economic Science*—SEYMOUR C. LOOMIS, 69 Church Street, New Haven, Conn.
K.—*Physiology and Experimental Medicine*—DONALD R. HOOKER, Johns Hopkins Medical School, Baltimore, Md.
L.—*Education*—STUART A. COURTIS, Liggett School, Detroit, Mich.

Treasurer

R. S. WOODWARD, Carnegie Institution of Washington, Washington, D. C.

Assistant Secretary

F. S. HAZARD, Office of the American Association for the Advancement of Science, Smithsonian Institution, Washington, D. C.

SCIENTIFIC NOTES AND NEWS

THE medals of the Royal Society have been awarded as follows: The Copley medal to Sir Ray Lankester, on the ground of the high scientific value of the researches in zoology carried out by him, and of the researches inspired and suggested by him and carried out by his pupils; a Royal medal to Professor H. B. Dixon, F.R.S., for his researches in physical chemistry, especially in connection with explosions in gases; a Royal medal to Professor E. H. Starling, F.R.S., for his contributions to the advancement of physiology; the Davy medal to Professor R. Meldola, F.R.S., for his work in synthetic chemistry; the Hughes medal to Dr. Alexander Graham Bell, on the ground of his share in the invention of the telephone and more especially the construction of the telephone receiver; the Sylvester medal to Dr. J. W. L. Glaisher, F.R.S., for his mathematical researches.

THE former pupils of Sir Henry Roscoe during the long period he occupied the chair of chemistry at Owens College, now the University of Manchester, decided some time back to commemorate the celebration of his eightieth birthday in January, 1913, by presenting his bust to the Chemical Society of London, and the formal presentation took place on November 21 at the society's rooms. Sir Edward Thorpe first presented to Sir Henry Roscoe an address signed by some 140 of his former students. He then unveiled the bust, and, on behalf of the subscribers, asked the president of the Chemical Society to accept it as a permanent memorial. He extended to Mr. Albert Drury, R.A., the thanks of the committee for the excellent and striking likeness that he had secured. He also asked Sir Henry Roscoe to accept as a further memento a replica of the bust for himself and the members of his family. The gift to the Chemical Society was accepted by the president, Professor W. H. Perkin. Sir Henry Roscoe then acknowledged the gifts, both to himself personally and to the Chemical Society.

PROFESSOR F. LOEFFLER, who since 1888 has occupied the chair of hygiene in the University of Greifswald, has been appointed director of the Koch Institute of Infectious Diseases at Berlin in succession to Professor Gaffky.

DR. J. N. LANGLEY, professor of physiology in the University of Cambridge, has been elected a corresponding member of the Munich Academy of Sciences.

THE Mary Kingsley medal of the Liverpool School of Tropical Medicine has been presented to Professor F. V. Theobald, vice-principal and zoologist of the Southeastern Agricultural College, Wye.

THE Bessemer gold medal of the British Iron and Steel Institute for 1914 will be awarded to Dr. Edward Riley, F.C.S., F.I.C.

AN appropriation from the Shaler Memorial Fund of Harvard University has been granted to Professor P. E. Raymond and Professor W. H. Twenhofel for an investigation into the correlation of the Ordovician and Silurian strata of the Baltic region with those of North America.

DR. L. W. STEPHENSON has been granted leave of absence by the U. S. Geological Survey, to occupy a chair of paleontology in the

University of California for four months, from January first.

ERNEST DUNBAR CLARK, Ph.D. (Columbia, '10) has resigned the position of instructor in chemistry in the Cornell Medical School to accept the position of soil biochemist in the Bureau of Chemistry, U. S. Department of Agriculture.

DR. BRUNO OETTEKING, who has received training in Germany and Switzerland, is working over the skull collection made in the course of the Jesup expedition of the American Museum of Natural History. The data are to be used in the final report on the physical anthropology of the expedition.

THE Salt Lake City office of the mineral resources division of the United States Geological Survey was recently moved to new quarters. The addresses of the three local offices of this division in the west and the geologists in charge of them are as follows: Charles W. Henderson, 311 Chamber of Commerce, Denver Colo. Victor C. Heikes, 312 U. S. Post Office Building, Salt Lake City, Utah. Charles G. Yale, 305 U. S. Custom House, San Francisco, Cal.

SIR AUREL STEIN, superintendent of the frontier circle of the archeological survey of India, has been deputed by the government of India to resume his archeological and geographical explorations in Central Asia and westernmost China, in continuation of the work he carried out between 1906 and 1908. For his journey to the border of Chinese Turkestan on the Pamirs he is taking on this occasion the route which leads through the Darel and Tangir territories, which have not been previously visited by a European.

ON Friday evening, November 21, there was a public meeting in the large auditorium of the American Museum of Natural History under the joint auspices of the museum, the American Scenic and Historic Preservation Society and the National Committee for the Preservation of the Yosemite National Park, with the cooperation of many civic organizations throughout the United States to protest against the act pending in congress proposing to grant the Hetch-Hetchy Valley in the Yosemite National Park for water-storage purposes. Addresses by Professor Henry Fairfield Osborn, president of the museum; Dr. George F. Kunz, president of the Scenic Society; Mr. Robert Underwood Johnson, chairman of the National Commitee; Dr. Douglas W. Johnson, of Columbia University, and others discussed the economic, geological and scenic features of the question.

PROFESSOR JOSEPH BARRELL, of Yale University, gave a lecture on "Some Physical Conditions which have Guided Evolution" before the Columbia Chapter of the Sigma Xi on November 25.

PROFESSOR AXEL L. MELANDER, head of the entomological department of the State College at Pullman, Washington, spoke on "The Control of Insect Pests," before the Brown University Chapter of the Sigma Xi on November 24.

DR. A. S. PEARSE, of the University of Wisconsin lectured before the students of the department of biology at Lawrence College on November 21, his subject being "Tropical Life in Colombia." The lecture, which was an account of a recent zoological expedition of which Dr. Pearse was a member, was illustrated by lantern slides.

THE Faraday Society of London devoted the meeting of November 12, 1913, to a general discussion on "The Passivity of Metals," to which it invited the following investigators to contribute papers: from England, Dr. G. Senter and Mr. H. S. Allen; from Germany, Professor Max LeBlanc (Leipzig), Professor G. Schmidt (Münster), Professor Günther Schulze (Reichsanstalt, Charlottenburg), Dr. G. Grube (Dresden); from Switzerland, Dr. D. Reichinstein (Zürich); from the United States, Professor E. P. Schoch (Austin, Texas). The papers and discussions will be printed under separate cover and also in the *Transactions* of the Faraday Society.

A LECTURE in memory of the late Professor Edwin Goldman was recently delivered at Freiburg University, Baden, by Professor Aschoff, who drew attention to his eminence

in surgery and to his valuable experiments in pathological anatomy.

Sir Robert Stawell Ball, Lowndean professor of astronomy at Cambridge University, and director of the observatory, died on November 25, at the age of seventy-three years. He was professor of astronomy in the University of Dublin and Astronomer Royal of Ireland from 1874 to 1892, when he was called to Cambridge.

Dr. Henry Potonié, geologist of the Prussian Geological Survey and professor of paleobotany in the Bergakademie, died on October 28, in his fifty-sixth year. He was widely known for his studies of paleozoic floras and for his recent work on the origin of coal.

Dr. Armin Balzer, professor of geology and mineralogy at Berne, has died at the age of seventy-one years.

Dr. Emil Ponfick, until recently professor of pathological anatomy at Breslau, has died at the age of sixty-nine years.

Section F—Zoology—of the American Association for the Advancement of Science will hold meetings at Atlanta, Georgia, on Monday and Tuesday, December 29 and 30. As the American Association rarely meets in southern territory a large attendance of southern zoologists is expected, and all northern zoologists who do not expect to be present at the meetings of the American Society of Zoologists at Philadelphia are urged to support the Atlanta meeting by presenting papers. The address of the retiring vice-president of Section F, Professor William A. Locy, of Northwestern University, upon "The Story of Human Lineage" will be given on Monday afternoon, December 29, at two o'clock. Professor Edmund Beecher Wilson, professor of zoology in Columbia University, will preside over the general sessions of the association as president of the association. Titles of papers to be read before Section F should be in the hands of the secretary, Professor H. V. Neal, Tufts College, Mass., before December 15.

It is said that the Paris Academy of Sciences has offered a prize of $2,000 to the person who devises a means for domesticating the heron in order to obtain aigrettes without killing the birds.

Mr. Austen Chamberlain has received from the secretary of state for India a contribution of £500 towards the enlargement and endowment of the London School of Tropical Medicine. The fund now amounts to £71,276.

In accordance with the provision giving preference to the same candidate for three successive years, provided said candidate should have proved herself efficient and fitted for the position, the fellowship of $1,000 of the Nantucket Maria Mitchell Association for the year beginning June 15, 1914, has been awarded to Miss Margaret Harwood. The year beginning June 15, 1915, is the quadrennial year provided for by vote of the board of managers on April 26, 1911; the appointee of three previous years of continuous efficiency is privileged on the fourth to avail herself of the entire year for study and research in an observatory of her own selection. In order that the Nantucket Observatory may be provided for from June 15, 1915, to December 15, 1915, the association offers a second fellowship of $500 for the quadrennial year.

On December 10, 11 and 12 there will be a conference on Safety and Sanitation, which will mark the opening of the first International Exposition of Safety and Sanitation, at the Grand Central Palace, New York City. The problems for discussion are:

December 10, morning—Subject, "Industrial Accidents." "Safer Shops," presented by Dr. William H. Tolman, director of the American Museum of Safety; "Human Values," by Don C. Seitz. Afternoon—Subject, "Accident Prevention and the Public." "Problems of Transportation," presented by a representative of the Pennsylvania Railroad; "Care of the Injured," by Dr. William O'Neill Sherman, chief surgeon of the Carnegie Steel Company; "Taking Chances," by Dr. Lucian W. Chaney, of the United States Department of Labor.

December 11, morning—Subject, "Industrial Hygiene." "Sanitary Welfare of Workers," by Dr. Thomas Darlington; "Physical Examination of Employees," by Dr. J. B. Hileman; "Industrial Plants, their Equipment and Surroundings," by Frank A. Wallis; "Proper Food for Workers," by

L. H. Brittain. Afternoon—Subject, "Industrial Hygiene." Chairman, Surgeon-General Charles Francis Stokes, U. S. N. "Occupational Diseases," presented by Dr. Alice Hamilton, of Hull House, Chicago; "Factory Lighting," by G. H. Stickney; "Ventilation," by Dr. D. C. Graham-Rogers; "Dental Hygiene," by Dr. Homer C. Brown.

December 12, morning—Subject, "Employer and Employee." Chairman, George B. Cortelyou. "Employer, Employee, and the Public," "What Accident Prevention means to the Worker's Family." Afternoon—Subject, "The Coming Generation." Chairman, William B. Wilson, United States Secretary of Labor. "Teaching a Child to Avoid Danger," presented by Dr. Gustave Straubenmuller, associate superintendent of New York city schools; "Changing Conditions in Municipalities," by Henry Bruere, director of the Bureau of Municipal Research.

THE second annual meeting of the Association of Alumni Secretaries was held in Chicago on November 21 and 22 with E. B. Johnson, secretary of the Alumni Association of the University of Minnesota, as president and Wilfred B. Shaw, secretary of the Alumni Association of the University of Michigan, as secretary. Representatives were present from some fifty universities and colleges. Many subjects were discussed concerned with alumni associations and the relations of alumni to their institutions. The next meeting will be held at Columbia and Yale universities in November, 1914.

THE proceedings of the eighteenth session of the International Congress of Americanists, held in London, May 27–June 1, 1912, are now ready, and will be sent to members immediately. Changes of address should be reported at once to the secretary, 50 Great Russell St., London, W. C. The work contains 566 pages of text, 50 plates, 236 illustrations in the text and 88 pages of preliminary matter, including an account of the meetings and a number of subjects of importance for the ethnography and archeology of the Americas.

AN animal reserve is to be established in Tunisia for the wild animals which are being rapidly exterminated there. For this purpose a mountainous stretch of 4,000 acres, with an adjoining marsh of 5,000 acres, has been secured near Bizerta and offers peculiarly advantageous conditions. There are already inhabiting this virgin district wild boar, hyenas, jackals, foxes, lynx, civet cat, porcupines, eagles, vultures, etc., besides many kinds of waterfowl, including a number of migratory species. The object is to isolate, so far as possible, this area, and reintroduce those species of animals which, through the spread of European civilization, has either been exterminated or driven beyond the frontier.

AN achievement of more than usual importance has been the crossing of the continent of Greenland at its widest section, which has been accomplished by the Danish expedition under Koch and Wegener last July. It will be remembered that Captain Koch commanded a division of the Danish expedition to northeast Greenland in 1906–8 and was in charge of the party which carried the exploration of the coast to the extreme northwest where a cairn left by Commander Peary was found and the eastern surveys thus connected with the western. A valuable report by Koch and Wegener upon the scientific results and especially the glaciers of that district has recently appeared and is a model of thorough and painstaking scholarship. The expedition for the crossing of Greenland was landed upon the ice of the northeast coast in July, 1912, and after an unsuccessful attempt to reach Queen Louise Land, Captain Koch decided to winter upon the inland ice. During a sledge expedition to Queen Louise Land at the end of October, the leader had the misfortune to break his leg through falling into a crevasse, and was in consequence laid up for three months. During the winter the temperature was generally fifty degrees below the freezing point and only in March could sledge work be resumed. On April 20, 1913, the expedition started to cross the continent with five sledges and five horses. During the first forty days the weather was extremely bad. On July 11 the last horse but one had to be killed, but on the next day the land of the west coast was sighted. Food now having given out and the

weather being extremely bad, the party remained for thirty-five hours without food under the shelter of a rock. Too exhausted to proceed, the explorers killed their dog and were about to eat the flesh when they saw a sailing boat on the fiord east of Proeven (near Upernivik in latitude 72° N.). By means of shots and signals they were able to attract the attention of those on board, by whom they were taken to Proeven. The expedition met one misfortune after another, and that the leaders under all discouragements pushed the undertaking through along original lines supplies a most remarkable record of courage, persistence and endurance. Some of their horses escaped, Dr. Wegener had the misfortune to break a rib and Captain Koch a leg which kept him in bed for three months. They started out upon the crossing on April 20, but their progress was much impeded by powerful westerly winds and driven snow which caused the pack horses much suffering. The last nunatak (rock island within the ice) of the group on the east coast was passed in longitude 27° west. The greatest altitude of the ice dome was met in longitude 42° west or on the western side of the medial line of the continent whereas all crossings hithertofore have shown the highest point of the ice dome to be to the eastward of the medial line. The land of the west coast was first sighted on July 2, but the surface streams and morasses of thaw-water offered such difficulties that two weeks longer were required to make the coast, the last horse and the last dog being killed for food. The junior leader of the expedition, Dr. Wegener, is a meteorologist of reputation and has published many monographs and a general text upon the free atmosphere. According to the *Geographical Journal,* from which many of these data are gleaned, the highest point along the route of the expedition was about 9,000 feet above sea level.

UNIVERSITY AND EDUCATIONAL NEWS

The Massachusetts Institute of Technology will receive about $100,000 as the residuary legatee of the late Frederick W. Emory, of Boston.

A bequest of approximately £250,000, is made in the will of the late Mr. W. Gibson, of London and Belfast, to institute a scheme for providing sons of farmers of counties Down and Antrim with educational advantages.

Professor John Perry, of the Royal College of Science, South Kensington, has been appointed a member of the South African University Commission which is to investigate matters connected with higher education and to consider the conditions under which the Wernher and Beit donations and bequests for the purposes of the proposed University of South Africa may best be utilized. The other members of the Commission are Sir Percival Maitland Laurence, formerly judge president of the Supreme Court of South Africa, who is the chairman, ex-Justice Melius de Villiers and the Rev. Mr. Bosman.

Mr. Alan G. Harper, of Magdalen College, Oxford, demonstrator to the Sibthorpian professor of rural economy, has been appointed to the Indian Education Service as professor of botany at the Presidency College, Madras, during the absence on leave of Professor Fyson.

Mr. Alexander McKenzie, head of the chemistry department of Birkbeck College, London, has been appointed professor of chemistry in University College, Dundee, in succession to the late Professor Hugh Marshall.

DISCUSSION AND CORRESPONDENCE

A PROPOSED RE-ARRANGEMENT OF SECTIONS FOR THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

One feature of the American Association for the Advancement of Science meetings which causes some inconvenience, to say the least, especially in recent years since the average attendance has passed the thousand mark, is the congested and heterogeneous character of the sectional programs. In some of the sections, as at present constituted, the large number of papers offered makes it necessary to restrict or eliminate discussions, thus defeating the main object of reading a scientific paper

to a critical audience before publishing it. Worse still, science is now so diversified and specialized that with only a dozen sections to cover the whole field no one person can appreciate all the papers read in any of the more populous sections, so that one who wants to be sure to hear a certain paper must often sit through several others which mean nothing to him.

For this state of affairs there are several possible remedies, each of which, of course, has some disadvantages. The one which seems most promising is to increase the number of sections. The organization of the Association to-day is not very different from what it was thirty years ago, although since that time several essentially new sciences have claimed recognition and some of the older ones have developed wonderfully. Incidentally the present sectional classification does not discriminate clearly enough between the true or pure sciences and the applied sciences or arts.

Some of the sections already divide into two or more groups with simultaneous programs at the annual meetings, and it is but a step farther to make the separation final, as was done, for example, when the biological section was divided into zoology and botany about twenty years ago. The council of the association at the Cleveland meeting last winter took steps in the right direction by establishing one new section, and proposing an amendment which when adopted will give them the power to create additional sections when desired.

The sections as they will be at the Atlanta meeting are as follows:

A. Mathematics and Astronomy,
B. Physics,
C. Chemistry,
D. Engineering,
E. Geology and Geography,
F. Zoology,
G. Botany,
H. Anthropology and Psychology,
I. Social and Economic Science,
K. Physiology and Experimental Medicine,
L. Education,
M. Agriculture.

Some of the apparent defects of this arrangement may be pointed out before a new one is proposed.

Comparatively few purely mathematical papers have been presented at recent meetings; but mathematics, if included in the American Association for the Advancement of Science at all, should theoretically have a separate section, for it is the foundation of all the exact sciences, and apparently no more closely connected with astronomy than with physics, engineering or logic. Astronomy too should be independent, unless its followers are too few to constitute a separate section. (Possibly some papers on optics and spectrum analysis could be diverted to it from Sections B and C to make up the deficiency, if necessary.) In the smaller colleges it is usually combined with physics rather than with mathematics.

Engineering is not a science in the same sense that physics, geology, etc., are, but rather a group of arts, based mainly on mathematics and physics. Such engineering papers as do not embody distinct contributions to the laws of physics or some other science might well be diverted to the programs of the various engineering societies. An engineer's specialty, like that of any other artisan, is knowing *how*, rather than *why;* and probably most engineers do not regard themselves as scientists at all.

Combining geology and geography in one section is convenient for those geologists who are interested in some phase of geography, and for those geographers whose chief interest is that phase of ecology which deals with the influence of land forms on human activities, but is hardly fair to the explorers, teachers of elementary geography, phytogeographers, zoogeographers and anthropogeographers, who are becoming more numerous every year, and some of whom are doing excellent work without making much, if any, use of geology. Geography certainly now deserves a separate section, as it has had in the British Association for over forty years. Some may still contend that it is not an independent science; but the same could be charged to chemistry, which is analogous to geography in some respects. For chemistry considers the chemical

composition of everything, and the properties of the elements and compounds, while geography in the strictest sense considers the areal *distribution* of everything on the earth's surface, and the properties—so to speak—of all the natural divisions of the earth.

Although it has been but a score of years since the zoological and botanical sections were separated, present conditions seem to call for further subdivision of each. Botany, for example—and a similar statement could be made with respect to zoology—is not a single science, but a group of sciences (plant taxonomy, physiology, geography, etc.), differing widely in point of view, method of treatment and personnel of followers, and having in common only the fact that they all deal with the vegetable kingdom, just as the distinct sciences psychology, anthropology, ethnology, sociology and economics all pertain to the human race.

At the same time an additional section ought to be provided for a class of investigations which has come into prominence since the beginning of the present century, namely, those dealing with mutation, Mendelism and other evolutionary problems. Some papers in this category have been presented to Section F, some to Section G, and some to joint meetings of the two. To a new section for this group might be assigned the much-abused term "biology." Biology was for a long time, and is still in some quarters, regarded as merely the sum of zoology and botany or, worse still, a mixture of a large amount of zoology with a small amount of botany.[1] Some also have treated it as practically synonymous with ecology, particularly animal ecology. But every science is known by its laws, and if biology is defined as the science of life its laws are those which apply to all forms of life and not to inanimate matter, namely, the laws of evolution and heredity.

Many if not most scientists are teachers, and consequently it is natural that when they assemble in large numbers some of them should wish to have formal discussions of educational problems, professors' salaries, university government, etc. But teaching is not a science, but an art, more closely connected with psychology than with any other science; and there are already quite a number of associations organized for the purpose of considering educational questions that lie outside the field of science.

Agriculture is another art, or group of arts, based mainly on plant physiology and ecology. However, the newly created section for agricultural science will be a convenient place for papers on fertilizers, soil toxins, etc., which in recent years have been offered in considerable numbers to Section C, the most crowded of all—or even to Section G—on soil formation and classification, a branch of geology in which very few geologists are interested, and on the physiology and ecology of cultivated crops, a somewhat neglected branch of botany.

The following table is now submitted as an illustration of how the number of sections might be advantageously increased. No doubt it has many shortcomings, which will be immediately apparent to others, and criticism of it will be welcomed. It is divided into two columns, the first containing the names of the sciences and the second a few arts correlated with them, the latter being mentioned mainly to illustrate the contrast between science and art, and the kinds of papers that might be admitted to the sectional programs whenever there happened to be a dearth of genuine scientific material. It is scarcely necessary to remark that the list of arts is much less complete than that of sciences.

SCIENCES	ARTS
Astronomy.	Chronometry. Navigation.
Physics and mechanics.	Hydraulics. Aeronautics. Optics. Mechanical and electrical engineering.

[1] At this point some readers might be interested to turn back twenty years and read the discussion on "the emergence of a sham biology in America," begun by Professor MacMillan in SCIENCE for April 7, 1893, and continued by others in later numbers of the same volume. Dr. Ramaley's note on "What is Biology?" in SCIENCE for January 12, 1912, is also of interest in this connection.

Inorganic chemistry.	Metallurgy. Assaying. Water analysis. Chemical engineering.
Organic chemistry.	Pharmacology. Food analysis.
Petrography, mineralogy, crystallography.	Economic geology. Mining engineering.
Dynamic geology, physiography.	River and harbor improvement.
Historical geology, stratigraphy, paleontology.	Geological mapping and correlation.
Agrogeology (soil science).	Agriculture (in part). Soil mapping and classification.
Biology, or genetics.	Plant and animal breeding. Eugenics.
Systematic botany. Paleobotany.	Economic botany.
Plant morphology and physiology.	Plant pathology, etc.
Plant ecology, sociology and geography.	Agriculture (in part). Forestry.
Systematic zoology. Animal morphology. Paleozoology.	Classification. Taxidermy. Restoration of extinct species.
Animal physiology, ecology and behavior.	Veterinary medicine. Economic entomology and ornithology.
Human anatomy and physiology.	Medicine and surgery. Hygiene.
Psychology.	Psychiatry. Pedagogy. Advertising.
Anthropology, ethnology, archeology.	
Sociology, demography, economics.	Finance. Civics. Legislation.
Geography.	Cartography. Exploration. Regional description.

Very likely it would be better to subdivide the physical, chemical and zoological sections more minutely, or at least differently. For example, it might be well to separate the electricians from other physicists, and the vertebrate from the invertebrate zoologists. In botany, too, the mycologists and bacteriologists have little in common with the students of flowering plants, and might reasonably demand separate sections, unless they are sufficiently accommodated by affiliated societies. Meteorology and climatology, with the related art of weather forecasting, have not been mentioned above, but they should have a separate section, unless their followers are too few, in which case it might be best to unite meteorology with dynamic geology, and climatology with geography.

Of course the more numerous the sections the more papers there will be which would be equally appropriate for two different sections; but this difficulty, which is inherent in all classifications, will be more than offset by the advantages of having the sections more homogeneous, and besides it can be partly overcome by joint meetings, as heretofore.

Incidentally some such classification as the above should serve not only for the purposes of the American Association for the Advancement of Science, but also for the scientific departments of a large university. About the middle of the last century, when the Association had only two sections, in some of our largest institutions of learning all or nearly all the sciences were taught by one or two men, as is done in some small schools to-day. Much more recently botany and zoology were usually included in the same department, and even yet few universities have more than one botanical or zoological department, or a separate chair of geography; the last-named, where taught at all to mature students, being usually combined with geology or even with pedagogy.

Roland M. Harper

College Point, N. Y.

SCIENTIFIC BOOKS

National Antarctic Expedition, 1901–1904. Meteorology Part II., comprising Daily Synchronous Charts, 1 October, 1901, to 31 March, 1904. Prepared in the Meteorological Office under the superintendence of M. W. Campbell Hepworth, C.B., R.D., Commander R.N.R. London, published by the Royal Society. 1913. 4to. 26 p., 1003 charts.

This volume completes such physical results of the British National Antarctic Expedition as were specifically taken under the supervision of the Royal Society. It is a monumental work of unusual polar value, and as such

marks an epoch in the meteorological history of the Antarctic regions.

The meteorological conditions of the antarctic and sub-antarctic regions are shown on 883 daily charts, which include 44,893 observations. Cooperation was obtained from 233 ships and 92 land stations, including several observatories. Through the courtesy of the leaders of the German (Professor von Drygalski), Scottish (Dr. W. S. Bruce) and Swedish (Dr. Otto Nordenskiold) Antarctic Expeditions observations were used from Kaiser Wilhelm II. Land, Laurie Island, South Orkneys and Snow Hill Island and Palmer Land.

One hundred and twenty supplementary charts exhibit for each month of the year (and for the year) the mean sea-level pressure and air temperature, with the mean temperature and the mean pressure for each month from October, 1901, to March, 1904.

The wind observations are also summarized in ten tables as to direction and force, arranged according to seasons, to related zones and to oceanic divisions.

Commander Hepworth is justified in setting forth the magnitude of the work, though his statement is questioned that the charts "refer to an area that is far larger than that embraced by any similar set of charts hitherto published." While true as to the Antarctic regions, he seems to have forgotten the daily charts of international meteorological observations, published by the signal corps of the United States army from July, 1878, to June. 1884, which covered the entire northern hemisphere and embodied observations from more than 1,000 regular observers.

The results as set forth by Commander Hepworth are of interest and value. "The average path of all central areas of depressions is found to have been in about the 52d parallel. Between the meridians of 20° E. and 150° E., it was between the 49th and 50th parallels; and between 150° E. and 70° W. in about the 55th." The average rate of travel is about 300 miles per day. One storm, with an average rate of 355 miles daily, was charted through a course of 2,840 miles. It may be added that the assumption of the late Mr. H. C. Russell is confirmed, that to the east of the 30th meridian E., centers of atmospheric depressions usually travel on paths south of the 43d parallel during winter, and south of the 46th parallel in summer.

Of special interest are the conclusions as to the general movements of the atmosphere. Commander Hepworth says: "The interchange of air between equatorial and polar regions may be effected through the intermediary of anticyclonic circulations, albeit these high-pressure systems are permanent; and in my opinion the temperature zones are bridged in this manner."

The charts of mean pressures clearly indicate a seasonal migration of high pressure belts in the Antarctic regions. This action is evidently general. Pointed out by Buchan in a general way, these atmospheric phenomena for the northern hemisphere were definitely set forth by the reviewer in a series of charts, published in Appendix 17, Annual Report of the Chief Signal Officer of the Army, 1891.

An incidental feature of this magnificent work requires notice. The Antarctic map of Volume I., 1908, omitted entirely Wilkes's Antarctic discoveries. The key map of Volume II. contains the legend: "Land reported by Commander Wilkes, U. S. N., 1840." Twelve months prior to the transmittal of the proofs of the introductory remarks, an Australian, Dr. Mawson, had not only visited this "reported" land but had established two scientific stations thereon, and to-day with courage and energy creditable to the British empire adds to the world's knowledge of this vast and ice-crowned continent, so long discredited.

A. W. Greely

THE BELGIAN ANTARCTIC EXPEDITION

Resultats du voyage du S. Y. Belgica en 1897–8–9, sous le commandement de A. de Gerlache de Gomery. Rapports Scientifiques. Géologie. Petrographische untersuchungen des gesteinsproben, II., von Dragomir Sistek. 1912, pp. 20, 1 pl. Zoologie. Tuniciers caducichordata (Asci-

diacés et Thaliacés) par E. VAN BENEDEN et MARC DE SELYS-LONGCHAMPS. 1913. Pp. 120. 17 pl.

The rocks reported on from the Antarctic are chiefly from Cape Gregory and Elisabeth Island. From the former locality granite and diorite, quartz porphyry, porphyrite, andesite and diabase, with a single specimen of basalt. Metamorphic schist and a quartz-feldspar conglomerate were also represented in the collection.

From Elisabeth Island, diorite, andesite, diabase and mica schist are reported.

The other rocks reported on are mostly from Punta Arenas and other points about the Magellan Straits and are of less interest.

A fine plate gives microphotographs of sections of the more interesting crystalline rocks.

The study of the Tunicates had been nearly completed by Professor Van Beneden when his researches were interrupted by death. But his text was entirely completed only for the Salpas and the plates referring to them. For the rest, notes, sketches, plates, etc., much remained to be coordinated and the text to be prepared by the later editor. With the exception of Plate VIII., all the plates are from figures left by Van Beneden. The classification adopted is that of Hartmeyer.

The Antarctic species collected by the expedition comprise two new species of *Corella* and a single *Boltenia*, which have been exhaustively monographed. The other species, also new, are from the Chilian coast. The Salpas are Antarctic and are the first brought from this distant region. They include one new species and a new variety of *S. fusiformis*.

The plates are of remarkable beauty and the work will add materially to the existing knowledge of the subject.

W. H. DALL

Abwehrfermente des tierischen Organismus gegen körper-, blutplasma- und zellfremde Stoffe, ihr Nachweis und ihre diagnostische Bedeutung zur Prüfung der Funktion der einzelnen Organe. Von EMIL ABDERHALDEN. Second edition. Published by Julius Springer, Berlin. 1913. Pp. ix + 199; with eleven text figures and one plate. Bound M. 6.40; paper covers M. 5.60.

In the second edition[1] of this booklet, the first appeared about one year ago, Abderhalden gives a clearer and more fully developed presentation of a defensive mechanism of the body which his researches have already shown to be of great interest and importance. Briefly stated, Abderhalden believes, on the basis of experimental work, that all soluble members of the proteid, fat and carbohydrate groups produce ferments when they come into contact with an organism's cells which are unaccustomed to their presence. The foreign proteid, for example, may be the characteristic proteid of another species, as when horse serum is injected into a dog, or it may be a proteid which is a characteristic component of the organism itself, but which through some process or other is found in localities where it does not normally belong, as when placental tissue components circulate in the maternal organism. In either case ferments are formed which digest the body-alien or blood-alien proteid. These ferments moreover are not specific when a proteid is injected in the crude laboratory experiment, but they are specific when the body inoculates itself, as for example during pregnancy. This specificity of the resultant ferment has made it possible for Abderhalden and his collaborators to make the differential diagnosis in hundreds of cases between pregnancy and non-pregnancy, practically without error, although many of them were complicated with cancer, salpingitis, tuberculosis, etc. This part of the work has been in general corroborated by other and independent workers. Abderhalden, however, carried the experimental development of this view still further. He argues that as all diseases must necessarily disturb the functional activity of some organ or organs, it is probable that these structures will form abnormal products. These abnormal products when thrown into the blood and lymph stream will act as blood-alien or cell-alien substances and will stimulate

[1] The first edition was reviewed in SCIENCE, 1913, Vol. XXXVII., p. 837.

the production of ferments specifically built to digest these foreign bodies. The test for these ferments is made by permitting the serum of the diseased individual to act upon the tissue of the organ at fault and searching for digestive products. The systematic test of organ after organ against the specific ferments formed would thus show which structure or structures was diseased, for only the pathologically altered organ or organs would undergo digestion.

It also would seem possible to study the interrelation of organs: when one organ is extirpated its absence affects some other structure or structures and causes the formation of abnormal metabolic products which in turn will betray their presence by the occurrence of specific ferments against themselves in the serum. Indeed, Abderhalden considers these defensive ferments, which are possibly formed by the leucocytes, as reagents for the detection of the characteristic structure of cellular constituents, and he justly points out that this conception opens up an enormous field for fruitful investigation.

The experimental technique for the detection of these ferments is full of difficulties. As the ferments themselves can not be isolated, their presence is proven, in the dialysis method, by demonstrating the occurrence of diffusible cleavage products after the serum has acted upon the prepared proteid. This demands a rigid asepsis to prevent bacterial contaminations. In addition there are numerous details upon whose observance Abderhalden emphatically insists. A full discussion of all these points, in fact a complete laboratory guide for the practical worker in this special field, forms an important part of the second edition of the booklet; this section will aid greatly in bringing about a full and rigid test.

From the short statement given above it will be seen that Abderhalden's brilliant development of this view concerning a defensive mechanism of the body has a breadth and promise which fully warrants the interest the scientific medical world has shown.

JOHN AUER

ROCKEFELLER INSTITUTE

Bovine Tuberculosis and Its Control. By VERANUS ALVA MOORE, B.S., M.D., V.M.D., Professor of Comparative Pathology, Bacteriology and Meat Inspection, New York State Veterinary College at Cornell University, and Director of the College. Ithaca, N. Y., Carpenter & Company. 1913.

The title of this book and the name of the author would naturally lead one to expect a complete treatise on this important subject. The book, however, is a distinct disappointment.

It contains 104 pages of matter by Dr. Moore. There is an appendix of 34 pages, which gives the Report of the International Commission on the Control of Bovine Tuberculosis, and following this are 30 plates, which for the most part are excellent.

The scope of the book can be understood by noting the space devoted to the different subjects. "The History of Tuberculosis in Cattle," occupies three and three fourths pages; "Distribution, Economic and Sanitary Importance of Bovine Tuberculosis" takes up nine pages. The "Sanitary Importance," which is included in this chapter, takes up one and three fourths pages. "The Symptoms of Tuberculosis" are given in three and three fourths pages, and so on. There is scarcely a subject which is adequately treated. In view of this, one would naturally look for a great many omissions of important matter, but it is hard to understand how even a cursory history of this subject can be given without referring to the work of the State Live Stock Sanitary Board of Pennsylvania, where for the first time in the world positive proof was given that the bovine tubercle bacillus was transmissible to human beings, this proof being adduced by the method laid down by Koch, namely, the isolation of cultures from persons who had died of the disease and the inoculation of cattle.

In the chapter entitled "The Cause of Tuberculosis," page 17, is sandwiched in some history and the statement that with Koch's announcement in 1901 "there began one of the most intense investigations into the nature of a disease that has ever been recorded."

For the truth of history it should be stated once for all that many investigations on this subject had been under way for years before Koch's announcement. At the laboratory of the State Live Stock Sanitary Board of Pennsylvania studies had been going on for three years previous to this, and at the Congress where Koch made his announcement a paper was read giving the results of these investigations, which to a large extent disproved the assertions of Koch. In 1902 the work from this same laboratory gave the final proof of Koch's fallacies. It is curious that the author of this book should have entirely omitted all mention of this work which has been widely published and certainly is easy of access.

The list of references is made up almost entirely of bulletins from State Agricultural Experiment Stations and the Bureau of Animal Industry, and no general list of useful papers on this subject is given. Among the references, Bulletin No. 75, Pennsylvania Department of Agriculture, 1901, is credited entirely to Pearson. It was a conjoint publication by Pearson and Ravenel.

The book lacks sequence. For instance, under "Method of Dissemination" in a summary by Peterson "on the finding of tubercle bacteria in the milk and excreta," on page 34, we find Abbott and Gildersleeve quoted on the relation between tubercle bacilli and other members of the acid-fast group.

Although Bulletin No. 75, Pennsylvania Department of Agriculture, is given as a reference, it is evident that the author gave as little attention to the contents as he did to the title. In the summary concerning the finding of tubercle germs in milk, which he quotes, he has entirely omitted the work given in that bulletin. This was quite an extensive piece of work, done with unusual care, and was among the first carried out in the United States on this point.

In a subsection on "Channels of Infection" we find the buying in of diseased cattle and infection through creamery and cheese factory by-products given—certainly not channels of infection.

The best chapter in the book, exclusive of the report of the International Commission on Bovine Tuberculosis, is that on Tuberculin, which occupies nine pages.

These criticisms will show that the book is not one that can be recommended, and it should not be dignified with the title which it carries. It might pass as an experiment station bulletin, but nothing more. It is to be regretted that the "cacoethes scribendi" will run away with the judgment of good men, and lead to the publishing of such a book as this.

Mazÿck P. Ravenel

University of Wisconsin

Catalogue of the Lepidoptera Phalænæ in the British Museum. Vol. XII. By Sir George F. Hampson, Bart. London. 1913. Pp. xiii + 626.

This volume contains the continuation of the family Noctuidæ, already partly treated in Volumes IV. to XI. of these catalogues. A part of the subfamily Catocalinæ is covered. A key to the genera is given, which will be reprinted in a more complete form in the next volume. Sixty-three genera with 643 species are fully described and a large proportion figured in colors in the accompanying book of plates, numbered CXCII. to CCXXI. The definition of the group, based on the presence of spines on the mid-tibiæ is somewhat artificial, as the author admits, but will probably not cause confusion in many cases. Otherwise it would be necessary to include this group in the already large subfamily Noctuinæ. The treatment is similar to that already familiar to us in the preceding volumes and is a welcome addition to this indispensable work.

Harrison G. Dyar

SPECIAL ARTICLES

SOME EFFECTS OF THE DROUGHT UPON VEGETATION

The summer of 1913 was exceedingly dry and hot in many parts of the United States, but the combination of climatic and edaphic factors which produce that complex effect included under the term *drought* appeared to center in southeastern Nebraska, eastern Kansas, northwestern Missouri and southeastern Iowa. Lines of extremely xerophilous condi-

tions radiated from this general axis for several hundred miles in nearly all directions.

During this period there were a number of days when Lincoln, Nebraska, experienced the highest temperature recorded by the eighty or more stations of the U. S. Weather Bureau which report to the Lincoln office. The dry period began at Lincoln on June 8 and continued until about September 8. According to the director of the Lincoln section of the Weather Bureau only 2.84 inches of precipitation was recorded for this period. This represents but twenty-five per cent. of the normal rainfall for this time at this station. Almost one half of this amount fell in such small quantities as to be of little benefit to vegetation. Weather records have been kept at Lincoln for thirty-two years and this is the lightest rainfall ever recorded for ninety-two days at this time of year. The normal precipitation for this period is 11.33 inches.

The temperature was high for the last part of June and the first half of July, but the first of the higher temperatures were recorded between July 13 and 17. These five days were very hot, the maximum temperature ranging from 102° F. to 109° F. More moderate temperature followed these first blistering days for about one week and then the remarkable hot period began. High temperatures prevailed with hardly a break from July 26 to September 7 or 8. During these forty-four days there were twenty-three days when the maximum temperature was 100° F. or more and it was below 90° F. on only seven days. On an additional number of these days the temperature went to 97° to 99° F. During the whole period from June 8 to September 8 there were twenty-nine days with a temperature of 100° F. or higher.

The relative humidity was low at various times during this long-continued "hot wave" and the conditions favoring desiccation were accordingly greatly magnified. Add to all these rigorous climatic conditions the influence of a strong wind which prevailed at times during the heated season and this region was at the mercy of the most extremely dry and protracted summer weather on record.

The most important effect of the drought is reflected in the greatly reduced yield of a number of the leading field, forage and garden crops, the products for which the territory is renowned. Fortunately the yield of winter wheat was not seriously impaired because that grain was so far advanced toward maturity at the beginning of droughty conditions that there was plenty of moisture in the soil (from a very promising spring) to satisfy the needs of that particular crop. In fact it appears that the yield of winter wheat for the year 1913 was considerably in excess of the average for practically all of the drought-stricken territory west of the Mississippi.

The second and third cuttings of alfalfa were, however, much less than normal for the region as a whole. Some farmers secured a very low return from the third crop of this legume. The yield of potatoes and other less important garden vegetables was also greatly affected by the hot dry days of the latter part of the vegetative season, although in certain parts of the region potatoes are yielding heavily.

Corn was the crop which suffered most, and, since the prosperity of the country is so often figured with reference to the yield of this crop, the effects of the drought appear unusually severe. Except in a few portions of this state (Nebraska) the yield of "King Corn" was very greatly diminished and in some parts, where at least *some* corn usually grows, absolutely no corn will be harvested.

One of the most noticeable effects of the drought upon the native plant life was seen in the shortening of the period of vegetative growth and in the hastening of flowering and fructification. This was noted especially with various herbaceous plants which apparently completed their summer activities several days or weeks earlier than usual. Early leaf maturity and leaf fall was common among native and exotic forest trees. In some cases almost all of the leaves had fallen by the end of July, while in nearly all of our trees noticeable early leaf fall was characteristic. Trees especially conspicuous in this regard in Lincoln were the

hackberry, *Celtis occidentalis;* elm, *Ulmus americana;* and Carolina poplar, *Populus.* These trees also showed great variations in the condition of their leaves, some individuals being nearly leafless at the same time (August) that others were quite normal. Many gradations occurred between these two extremes. The ash, *Fraxinus lanceolata,* was apparently affected to the least degree of all of our commoner tree species. Street trees in general suffered greatly and many such individuals perished during the summer. One man, the owner of a very attractive home and grounds in another city of the state, told me that he had kept three lines of hose constantly pouring water into the ground about his trees throughout the summer and that even then some of the trees were affected by the dry weather.

Toward the close of the summer it was noted that a number of the trees that had lost practically all of their earlier leaves had developed many new bright green leaves, which, however, were much smaller than the typical leaves of the species. The most conspicuous examples of this phenomenon occurred in the hackberry and in the Kentucky coffee tree, *Gymnocladus dioica.* Some trees of the former species put forth practically a full number of new leaves, but the small size of the late leaves made such trees rather noticeable. Many clusters of short compound leaves with very small leaflets appeared upon the almost bare, club-like branches of the coffee tree. In this case the new leaves came from dormant buds situated at some distance below the shoot apices.

Native woods along the streams of the eastern part of Nebraska were unusually dry and barren. The usual mesophytic undergrowth was greatly reduced in volume and few species of the usual summer and early autumn fungi were to be seen. The rich soil of the more open parts of such woods became as dry and powdery as that of the fields and some of the moisture-demanding plants of such habitats dried up and disappeared long before the usual time. Many of the spring-fed streams of the woodlands disappeared completely and the ravines became desiccated to a very unusual degree.

Native pastures suffered greatly and after July 15 little or nothing of forage value was to be found in such places. The ground became very dry and in some places broke into great blocks of extremely hard soil with prominent fissures between the solid masses.

The dryness of native vegetation and fields along the railroads resulted in the starting of an unusual number of fires by sparks from passing locomotives. Such blazes destroyed considerable grain in the shock or stack and in at least one case resulted in the death of a farmer and several of his horses. During a trip across the state early in September it was noted that many fires had been kindled in this manner so that the railroad right-of-way and sometimes for considerable distances on either side the grass or stubble had been destroyed by fire for long distances. Groves of planted trees or rows of trees along the railroad were frequently damaged or completely killed. This indirect effect of the drought seemed to be unusually common in many parts of the drought-stricken territory.

As cooler and moister weather succeeded the trying drought numerous cases of renewed activity on the part of vegetation were evidenced. The most pronounced late season reaction of this sort was observed in the re-greening of lawns, pastures and roadsides which had appeared as areas of stubble for so many weeks. The fresh green of early October is most welcome evidence of the fact that vegetation was not entirely burned out under the protracted desiccation of the long summer weeks.

Examples of the autumnal flowering of trees have been noted in greater than usual number. That this phenomenon is not induced in all cases by the succession of moist weather after a period of drought (as is commonly supposed) is shown in the case of a cherry tree on the campus of the University of Nebraska. This cherry tree, *Prunus padus,* came out with its second production of flowers early in September before the drought had been "broken." A striking additional peculiarity of the serotinal flowers of this species was seen in the presence of many abnormalities or malformations. Phyllody of various flower parts was especially common. Many of the racemes were in fact

transformed into veritable museums of teratological specimens.

RAYMOND J. POOL
THE UNIVERSITY OF NEBRASKA,
October 10, 1913

AN ANCESTRAL LIZARD FROM THE PERMIAN OF TEXAS

THERE has been no more vexed problem in vertebrate paleontology than the origin of the scaled reptiles. The theory generally accepted has been that the lizards arose from the double-arched or rhynchocephalian type by the loss of a primitive lower arch, a theory of which I have been skeptical for many years past. I have urged in various publications for the past ten years that the lizard phylum is a very ancient one, predicting that it would eventually be discovered in the Permian, a prediction that I am now able to verify. Three years ago I described briefly a peculiar reptile from the Lower Permian of Texas under the name *Arœoscelis*. It has only been recently that the stress of other material has permitted the full preparation of the several more or less complete skeletons upon which the genus was based, a study of which has disclosed more decisively than in any other American Permian reptile the structure of both skull and skeleton. *Arœoscelis* was an extraordinarily slender, long legged, cursorial and arboreal reptile of about eighteen inches in length. The skull is remarkably lizard-like in appearance and structure, with a typical upper temporal vacuity bounded precisely as in the mosasaurs. The sides of the skull below the arch, instead of being open, as in the lizards, are covered over by a broad expansion of the squamosal bone, which is rather loosely united to the quadrate. The quadrate is supported, as in lizards, by the tabulare and opisthotic; it is rather free and is broadly visible from behind. The lacrimal bone is small, as in lizards, a character hitherto unknown among ancient reptiles; and the palate has rows of teeth on all the different bones. The neck has seven or eight more or less elongated vertebræ, the dorsal region twenty. The sacrum is almost indistinguishable from that of lizards. The pectoral and pelvic girdles differ chiefly in their old-fashioned characters. The tail was slender and long. The feet have an elongated calcaneum and a reduced astragalus, unlike those of the known contemporary reptiles. Finally the attachment of the ribs, one of the most peculiar characters of the Squamata, is by a dilated head, articulating with both arch and centrum.

To convert *Arœoscelis* into a modern lizard would require the reduction of the squamosal bone from below to a slender bone articulating with the postorbital; the closer fusion of the postorbital with the postfrontal; the greater freedom of the quadrate; the loss of the posterior coracoid bone and a modernizing of the girdles, every one of which characters we are quite sure must have been present in the ancestors of the Squamata.

Arœoscelis can not be placed in any known order of reptiles, unless it be admitted to the Squamata. But, I do not think that the differences from the Squamata will justify its ordinal separation, if we are to classify organisms phylogenetically. I would rather modify the definition of the order Squamata to include the genus as the representative, doubtless with *Kadaliosaurus* also, of a distinct suborder, the *Arœascelidia*. Several years ago I recognized in another Permian vertebrate a primitive salamander, bearing about the same relations to the modern Urodela that *Arœoscelis* does to the modern lizards. The urodelan character of *Lysorophus* has now been generally accepted, and I believe that after I have published the full details of the structure of *Arœoscelis* I shall find concurrence in its phylogenetic association with the Squamata.

I regret much to add that Dr. Broom's inexperience with the American Permian vertebrates has led him into several errors in his recent discussion of the affinities of *Arœoscelis,* based upon the meager details which have been published. Had he heeded Dr. Case's warning I do not think he would have so readily assumed that the skull and skeletal bones which he described as *Ophiodeirus* really belong together. They probably do not, for

the skeletal bones are those of *Aræoscelis*, as he himself suspected. It is unnecessary to add that his conclusions, based upon erroneous premises, are wholly incorrect. *Aræoscelis* is as widely separated from *Bolosaurus* as is any other known American Permian reptile, at least so far as can be judged from the skull as Dr. Broom has restored it.

S. W. WILLISTON

UNIVERSITY OF CHICAGO,
November 8, 1913

THE CONVENTION OF GEOLOGISTS AND MINING ENGINEERS

IN connection with the National Conservation Exposition conducted in Knoxville, Tennessee, during September and October, there was held a meeting of geologists and mining engineers for the purpose of discussing problems connected with the conservation of the natural resources of our country and especially of the south. Delegates were present from most of the southern states and many from the north and west.

The papers and discussions were of a high order and it is hoped that arrangements can be made to have these in print at an early date. Following are the titles of papers read:

"Economic Non-metallic Minerals of the Southern States," by Dr. J. Hyde Pratt.

"Inventory of the Mineral Resources of Georgia," by S. W. McCallie.

"Conservation as Applied to Mining Lime Phosphates," by E. H. Sellards.

"The Regulation of Oil and Gas Wells, Especially When Drilled Through Coal Seams," by Richard R. Hice.

"The Iron Resources of the World," by Dr. E. A. Schubert.

"Possible Dangers to Mines in Drilling for Oil and Gas in the Coal Measures," by Edward Barrett.

"The State Geologist and Conservation," by Dr. A. H. Purdue. (Read by title.)

"Oregon Problems of Resource Development," by H. N. Lawrie.

"Relations of the Forest Service to the Conservation of Mineral Resources of Mineral Lands," by Don Carlos Ellis.

"Soil Survey and Conservation *vs.* Soil Mining," by H. A. Hard.

"The Conservation of Natural Gas in the Mid Continent Field," by C. N. Gould.

"Gypsum and Salt Deposits of Southwest Virginia," by F. A. Wilder. (Read by title.)

"Scenic Beauty and Its Variation as Influenced by Geological Origin," by George F. Kunz. (Read by title.)

"Sane Development of the Mineral Resources of the South," by E. J. Watson. (Read by title.)

C. H. Gordon was elected chairman of the convention and F. W. DeWolf, state geologist of Illinois, secretary.

The following resolutions were adopted:

WHEREAS, The burden of classification of our public domain rests heavily, and perhaps unjustly, on the applicant desiring to title such lands, and

WHEREAS, Many conflicting interests with the consequent loss and embarrassment to the land and mineral claimant results from an absence of adequate classification of the federal domain, and

WHEREAS, There are not sufficient funds available for the purpose of expediting the work of classifying the federal domain, and

WHEREAS, It is recommended by this convention of geologists and engineers assembled at the National Conservation Exposition, at Knoxville, Tennessee, September 19, 1913, that this work be accelerated, and that the same should be comprehensive so as to include the possibilities of agriculture, timber, hydro-electric and mineral development and, if practicable, simultaneously; be it therefore

Resolved, That we, the members of the convention of geologists and engineers assembled, memorialize Congress of the United States to increase this appropriation sufficiently to enable the work as herein noted to be carried out efficiently by the Departments of the Interior and Agriculture.

WHEREAS, There has been an extended argument concerning the merits of state versus federal control of the national forests; and

WHEREAS, The Oregon Conservation Commission has made an exhaustive study of this subject, which resulted in their conclusion in favor of federal ownership; be it therefore

Resolved, That we, the members of this convention of geologists and mining engineers, assembled at this National Conservation Exposition at Knoxville, Tennessee, September 19, 1913, do hereby endorse the findings of the Oregon Conservation Commission in favor of the federal ownership of the national forests.

SCIENCE

Friday, December 12, 1913

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

MEMOIR OF JOHN SHAW BILLINGS[1]

It has been the custom of the National Academy of Sciences to commemorate in memoirs those whom death has removed from its ranks. Since the lives of men of science are little known except to those engaged in their own lines of research, some record is the more to be desired of one who illustrated the fact that scientific capacity may exist with varied ability for the conduct of large affairs. This combination of talents has been often found in the ranks of the Academy, although in the belief of the public, the man of science is presumed to be incapable of the successful management of commercial business.

The many tasks to which his life of work summoned the subject of this memoir have become, since his death, for the first time so widely known that it is unnecessary for me to do more than to put on paper a brief summary of his career and the reasons for his election to this distinguished body of men of science, where from 1887 to 1889 he rendered efficient service as our treasurer and served on eight important committees or as a member of our council. The life of our fellow member, in fact, needs less restatement from us, because since he died at least a half dozen men of importance have recorded their opinions of this attractive and much-loved man and of what he effected during his ever-busy existence. Moreover, a full and competent biography has been undertaken, and will, I am sure, do ample justice to one who owed nothing to newspaper notoriety. Through his mod-

[1] Read before the National Academy of Sciences, Baltimore, November, 1913.

est life of the labor he loved he accepted grave burdens and whatever duties, official or other, fell to him, apparently indifferent to praise or popular reputation while he dealt victoriously with tasks so various in their nature that any one of them would have sufficed to tax the technical competence of the most able man.

John Shaw Billings was born in Switzerland County, Indiana, April 12, 1838. From the time he went to college until after the end of his medical studies he was almost entirely without exterior aid. He was graduated from Miami University in 1857; A.M. in 1860. His personal struggle for a college education and the sacrificial privations by which he attained his medical degree in 1860 from the medical college of Ohio will, I trust, be told in full elsewhere. He won his way unhelped by taking charge of the dissection rooms and for one entire winter, as he assured me, lived on seventy-five cents a week, as he believed to the serious impairment of a constitution of singular vigor.

Hospital service gave him what the imperfect medical teaching of that day did not give and, as demonstrator of anatomy, he prepared himself for surgical practise, which was to find its opportunities in the clinics of the battlefield.

In the year 1861 came one of the many periods for decisive choice he was to encounter as life went on. A certain career as assistant to a busy surgeon was offered him. His strong sense of duty to his country made him decline the tempting opportunity and he entered the regular army first of his class in a competitive examination and was commissioned assistant surgeon, U. S. A., April, 1862.

To deal briefly with his army career, he became surgeon captain in 1866, surgeon-major in 1876, and colonel and deputy surgeon general in 1890. He was retired from active service in 1895 by President Cleveland at his own request and through the influence of the University of Pennsylvania, which at this time offered him the place of professor of hygiene.

During the war he was breveted major and lieutenant-colonel for faithful, gallant and meritorious service. Dr. Billings won in the field a high reputation as a very skillful and original operative surgeon, and a character for courage and resourceful administrative ability on many occasions, but especially when after the disastrous battle of Chancellorsville he conducted the retreat of the wounded and when later he was actively engaged in perilous service during the battle of Gettysburg.

While in army service he began very early to exhibit his constructive talent in altering or building hospitals, and his remarkable power of administrative command in these vast homes of the sick and wounded.

Without dwelling too much on this part of his career, I may say that there were many months of service in the field and also as an acting medical inspector of the Army of the Potomac. Dr. Billings's war service with the army ended when, in December, 1864, he was ordered to Washington, where he had charge of the invalid reserve corps, of matters relating to contract surgeons and a variety of other business.

Some time in 1864 he was sent by the President with others to the West Indies on an errand connected with the futile plan for deporting some of our recently made freedmen to an island. This scheme appears to have failed, as might have been expected, and probably the expedition in which he was included was meant to bring back the men previously thus deported. It was a somewhat fantastic scheme and I do not find any account of it in the histories

of the war. Probably Dr. Billings had an important share, for here, as elsewhere, no matter what his relation was to a body of men and officers, his peculiar talents soon found their influential place.

It becomes clear from what I have already said that his capacity to turn with ease from one task to another must have become by this time very well known to his superiors. His own desire was to return to the field, but the promise to so indulge him probably failed owing to the somewhat abrupt termination of the war. Meanwhile he was required to deal with the voluminous medical reports sent in by the medical staff of the Potomac Army. The records of this work and of his other more individual surgical contributions are scattered through the voluminous medical and surgical history of the war. Here as elsewhere he left in these papers his mark as a man of many competencies.

Some of the duties to which he was assigned before his retirement were curiously outside of the work of a military surgeon and he seems to have been lent by the War Department for a variety of governmental services. Thus while busy with the early work in connection with the museum and library, he was also occupied with the organization of the United States Marine Hospital Service in 1870. In 1872 he was vice-president of the brief lived National Bureau of Health, and was for a long period in charge of the division of vital statistics of the eleventh census of the United States.

During his career as a surgeon in the years before 1895, he became an authority on military medicine and public hygiene and revived his interest in hospital construction to which he had given a great deal of thought. He was one of five who submitted in 1875, by request, plans for the construction of the Johns Hopkins Hospital. His careful study of the conditions required in a hospital were accepted. They included many things novel at that time which it is not needful for me to dwell upon here, but some of them were very original changes from the organization and construction to be found in hospitals at that period.

During these years he went to Baltimore from time to time and lectured on the history of medicine and on hygiene. He also supervised the planning and construction of the Barnes Hospital of the Soldiers' Home, Washington, D. C., and later the buildings needed for the Army Medical Museum and the Surgeon General's Library. His final constructive work late in life was his connection with the plans for the Brigham Hospital in Boston and during many years he was continually consulted by institutions or cities in regard to hospitals and hygiene questions of importance.

The great work of John Shaw Billings which gave him finally a world-wide repute began at some time after 1864, when he was asked by the surgeon general to take charge of the army medical museum created under Surgeon General Hammond by the skillful care of Surgeon John H. Brinton. His formal assignment "in charge of the Museum Library Division and as curator of the Army Medical Museum" dates from December 28, 1883, but he had been informally librarian for many years before that time. It is quite impossible here to enter into any detailed account of the ingenuity and power of classification which has made this museum the greatest presentation of the effects of war on the bodies of men. It is, however, essential to say a few words about the varied capacities which built up and made finally available to scholars the library of the surgeon-general, now the

most completely useful collection of medical works in the world.

In some reminiscences of his younger days he speaks of his student aspiration "to try to establish for the use of American physicians a fairly complete library and in connection with this prepare a comprehensive index which should spare medical teachers and writers the drudgery of consulting thousands or more indexes or the turning over the leaves of many volumes to find the dozen or more references of which they might be in search." The opportunity he craved when young came now by singular good fortune into his possession. When he took hold of this work, the surgeon-general's library contained a little over a thousand volumes and all interest in its increase had been long at an end. Fortunately, as I so understand, at the close of the war there fell into the hands of the surgeon-general some eighty-five thousand dollars, the result of hospital savings during the great contest. He was allowed to use this money for the building up of the museum and of the library, which was an essential adjunct to the collection. It was a vast piece of good fortune that this task fell to the man who had craved such a chance since his youth. He brought to it powers which are rarely united in one man and an amount of knowledge of books, medical and non-medical, which few possess. When he was nominated for membership in the National Academy of Sciences, his claim to this high distinction was judiciously founded by his friends upon his application of skill in the scientific classification of books and of the medical knowledge of our profession through the centuries. No medical librarian who ever lived had, up to that time, shown such an almost instinctive capacity for the scientific classification of knowledge so as to make it readily available. It was eminently a scientific gift and of incredible usefulness in its results to the scholarship of medicine throughout the world.

When he gave up this charge at the time of his appointment to the chair of hygiene in the University of Pennsylvania, he received from the physicians of Great Britain and America at a dinner given in his honor a silver box containing a cheque for ten thousand dollars, as a material expression of gratitude for the labor-saving value of his catalogue.

The surplus of this fund enabled his friends to present to the Surgeon-General's library an admirable portrait of John Billings, by Cecelia Beaux.

The library as he left it contained 307,455 volumes and pamphlets and 4,335 portraits of physicians. At the present day in the skillful hands which took up his task, it has reached over half a million volumes and over five thousand portraits and has a unique collection of medical journals quite matchless elsewhere.

He went about the preliminary measures for the catalogue with cautious care and in 1876 prepared a specimen fasciculus of the proposed catalogue of the library, consisting of a combined index of authors and subjects arranged in dictionary order, and submitted it to the profession for criticism. In this he was aided by his able assistant, Dr. Robert Fletcher. In the first series of the index catalogue, 1880–1895, the material was selected and a scientific classification made by Billings. As a monthly supplement to the index catalogue, the Index Medicus was begun by Dr. Billings and Dr. Fletcher in 1879 as an extra official publication. When, in 1903, the second series of the Index Medicus was issued, it was seen that there was a risk of failure in this invaluable publication through want of means, but at this time by Dr. Billings's influence through the aid of the Car-

negie Institution of Washington, it was permanently established at the cost of some twelve thousand dollars a year and continues to be a helpful aid to scholarly physicians all over the world.

It was thus that Dr. Billings got his trainings for the still larger task which awaited him when he was chosen as librarian of the Astor-Tilden-Lenox library in New York. There at once this great enterprise found in him all the varied qualities which were needed in the construction of the building, the classification of its contents, the efficient administrative grasp on the forty outlying libraries of New York connected with the triple library, and in his singular power of uniting strict discipline with a capacity to attach to him those under his control.

Throughout his life he was a busy writer of essays on hygiene, hospital construction and administration, the statistics of war and addresses or essays such as his history of surgery, perhaps the best presentation of this subject ever made.

To comprehend the character of a man, he must have been seen in his relation to the various duties which test the qualities of both heart and head. The charge of suffering, crippled, wounded soldiers is a trial to the surgeon and here he showed the man at his best. He was patient with the impatient, never irritable with the unreason of sufferers, never seeming to be in a hurry, and left at every bedside in the long sad wards the impression of being in earnest and honestly interested.

It was thus I first knew John Billings when in the crowded wards wearied, homesick men welcomed his kindly face and the almost womanly tenderness he brought to a difficult service.

My own personal relations with John Billings began in the Civil War when he had for a time the care of my brother, a medical cadet, during a mortal illness contracted in the Douglas Hospital, Washington. I saw then how gentle-minded was this man and how he realized the pathetic disappointment of a highly gifted young life consciously drifting deathward. I saw thus a side of John Billings he rarely revealed in its fullness. Generally a rather silent man, he was capable now and then of expressing in eloquent brevities of speech the warmth of his regard for some one of the few he honored with his friendship. In the last talk I had with him, he said to me some things which remain as remembrances of this rather taciturn and reserved gentleman. I had asked him how many degrees and like honors he had received and, considering these notable recognitions, I remarked on the failure of popular appreciation. He replied with a jesting comment and then said, after a brief silence, that he was far more proud of his capacity to win the friendship of certain men and of the service he had been able to render to science in his connection with the Carnegie Institution of Washington. There indeed his always wise and broad-minded interest will be greatly missed. I served with him from its foundation on the distinguished executive committee of this body. Here, among men he liked and trusted, we saw him at his familiar best. Always a patient listener, his decisions as chairman were expressed with his quiet, courteous manner, and many times his large knowledge of the science of the day left me wondering how it could have been attained amid the amazing number of occupations which had filled his time. But in fact he was intellectually sympathetic with every form of scientific research, a somewhat rare characteristic among investigators. I ought also to say that the men of our committee and of the board of trustees felt at times a little surprise at the shrewdness, the common sense

and the commercial insight he brought to the critical financial consideration of this immense money trust. Not elsewhere was he better seen or understood as conveying the sense of character, and nowhere else was he better loved.

Numberless presidencies of societies fell to his share, and the list of his honorary titles from all of the greater academies and universities at home and abroad served at least to show in what esteem he was held by men of science. These recognitions gave, I suspect, more pleasure to his friends than to this retiring and singularly unambitious scholar.

On public occasions, his personality stood for something in the estimate of the man. Tall and largely built, he was as a speaker in the after-dinner hour or when addressing a body of men a commanding presence, with flow of wholesome English, ready wit and humor such as rarely came to the surface in his ordinary talk. The figure of athletic build, the large blue eyes, a certain happy sense of easy competence, won regard and held the respectful attention of those who listened. For me there was always some faintly felt sense of that expression of melancholy seen often in men who carry through a life of triumphant success the traces of too terrible battle with the early difficulties of their younger days.

What was most exceptional in this man was the unfailing fund of energy on which he drew for every novel duty and an industry which never seemed to need the refreshment of idleness. He had that rare gift—the industry of the minute. When once I spoke of the need for leisurely play and the exercise of open-air sports, he said that he obtained recreation by turning from one form of brain use to another. That was play enough. I ought to add that he found pleasure in reading novels, saying that one or two of an evening late were agreeable soporifics. But these, like more serious books, he devoured rather than read as most men read, and what he read he seemed never to forget. His memory was like a good index of a vast mental library.

Until his later years Dr. Billings possessed the constitutional vigor which befriended him earlier as he responded to the call of a succession of military and civic duties. Of late years he was obliged to undergo several surgical operations of serious nature. He went to them with confidence and courage, but before the last one he said to me, "I am for the first time apprehensive." He went on to add, "It is a signal of age; and of late, as never before, any new project, any need for change in the affairs of the library, I find arouses in me an unreasonable mood of opposition. This too is, I know, a sure evidence of my being too old for my work. I shall, I think, resign my directorship of the library." It was our last intimate talk. He died of pneumonia after the operation, on the eleventh of March, 1913.

The scene at his burial in the military cemetery at Arlington brought together many men of distinction, a much moved group of army men and the great library officials. We left in the soldier burial ground all that was mortal of a man who combined qualities of head and heart such as none of us will see again.

Dr. Billings married Miss Kate M. Stevens, in September, 1862. Their children are: Mary Clure, Kate Sherman, Jessie Ingram, John Sedgwick and Margaret Janeway.

Science is forever changing. The work of to-day is contradicted to-morrow. Few indeed are so fortunate as to leave in the permanent remembrance of science conclusive work. The man whose loss we regret

left to medicine in his catalogue of the Surgeon General's Library a monumental labor which none will ever better and to which he gave continuity of vigorous life.

S. Weir Mitchell

THE DUTY OF THE STATE IN THE PROSECUTION OF MEDICAL RESEARCH[1]

It is an interesting manifestation of apparent humility and unwonted lack of self-conceit that man should have hesitated so long to emphasize the primary responsibility of the state for the physical well-being of its citizens. Health is a fundamental resource not only of the individual, but, in a very real sense, of the state itself. The happiness, the efficiency, and even the existence of every citizen is threatened by the presence of disease in the individual home. It would be interesting to discuss why an educated nation has so long permitted the existence and even encouraged the extension of sickness and disease among its citizens by failing to take means for the correction of the individual evil, and for the prevention of its dispersal among other unaffected members of the community. Discussion of this feature would demand more time than is reasonable on this occasion, and it is sufficient to have indicated the existence of influences which stand in the way of efficient work for the conservation and improvement of public health.

The state university has been organized and developed by the state in order to supply that trained knowledge which is essential for the comprehension and solution of modern problems. Unwilling that all knowledge should come to the public through private citizens, or that the dissemination of knowledge and the methods of its application should be dependent upon the liberality of the fortunate individual or in any way hampered by the conditions under which private munificence is granted and expended, the state itself, that is, the common men and women of the community working together, have contributed each one of their means and according to their ability that they may have in their midst a center of influence ready and able to gather the best knowledge from all sources, to assimilate it to their purposes, to apply it for their protection and advancement, and thus to make possible a broader and richer and freer and fuller life than they working singly could ever attain. Every man and every woman in the entire commonwealth who has sufficient honor and self-respect to pay taxes has contributed to the support of the state university as a whole, and of every one of its individual departments. The responsibility that the university and every one of its individual departments assumes is thus definite and grave. It involves the very best possible application of funds which represent many instances of self-denial and privation on the part of individual citizens that it may further the interests of every one of those citizens in the most efficient manner. This is the problem which stands before the medical department of the University of Nebraska in its new quarters so generously provided and admirably adapted for the work of medical education, primarily in its relation to the state of Nebraska itself, but since we are all members of one nation, and of one family of nations, in constant, intimate, and unavoidable contact with each other, really also in its relation to the nation and the entire world.

Men look at things from different points of view. Toiling up the steeps of knowledge, we reach different coigns of vantage, from which we may look out and get a somewhat imperfect and incomplete view of the achievements of the past, and the paths that lead on to the higher attainments of

[1] Address at the dedication of the medical laboratories at the University of Nebraska.

the future. The view that each one gets is imperfect, and there are few of us who feel that we have risen high enough to command a really broad and comprehensive survey of the situation. For my part, it is with great diffidence that I express any opinion, especially in the presence of the deservedly famous scholar and investigator who follows me, and who has contributed in many ways so definitely and richly to the progress of the nation in medical matters. And yet there are some elements in the responsibility, as I see it, of this institution to the community which has founded and is supporting it, that are unmistakable in their appeal to every one. If they appear to you so commonplace that you wonder at their recital here, may I suggest that the restatement of fundamental relations is not only valuable but indispensable when, on such occasions as this, men and women come together to do honor to a great institution and set the seal of public approval on the facilities which it has created for work, as well as to give inspiration and direction to the increased influence and opportunity that grow out of the greater possibilities in the new environment. There is always some danger that a new movement loses sight of fundamental responsibilities, and in emphasis upon one opportunity forgets to do equal justice to the others that surround it and rightly expect their appropriate attention and emphasis. What are the primary duties of this school in its new home? Only those laid upon it at its organization, even though now in a richer environment they acquire a new and stronger emphasis.

The first duty that suggests itself in any discussion of the state university is that of education, and in the minds of many the duty is limited to its narrower significance of the word, *i. e.*, to training in set classes and courses those who present themselves with adequate preparation and fixed purpose to achieve the special end they seek. But many universities have neglected to consider that it is neither possible nor desirable for the single institution to give instruction in this narrow sense to each and every citizen desiring the training. Many of our state universities have hampered their usefulness by striving to teach more students in more ways than the means at their command would justify. They have duplicated opportunities of the routine sort and have been overwhelmed by masses of elementary students whose training added little except political strength to the influence of the university or to the welfare of the state, and only mere commonplace finish to the training of the individual. Every time the university takes a student from another institution, either high school or academy, college or technical school, before he has legitimately utilized the opportunities which that institution offers for his purposes, it has contributed to the disintegration and destruction of the educational strength of the community. Every time a university admits a poorly trained or mentally incompetent student or retains in its class-rooms a time-serving, shirking idler, indifferent to his opportunities, it does a grave injustice to the energetic and ambitious workers in its halls, and may fairly be charged with misuse of public funds. In the mad rush after students, all of our institutions alike have added to their own weakness rather than to their own vigor, and have wasted the resources of the people insofar as they have taken part in the struggle after mere bigness.

If it be no proper ideal to gather in numbers at the expense of fitness, it is certainly a clear function of the state institution to set minimum standards for the entire commonwealth, to indicate what is reasonable training in a given field, and to prevent

the exploitation of the uninformed by private institutions that pretend to prepare, but do not really fit, students for the life work which they are aiming to pursue. Nowhere is the necessity for establishing standards and fixing the conditions of reasonable preparation for professional work more essential than in the medical school. The poorly trained engineer fails to achieve individual success but usually never reaches a stage of independent action in which his lack of training becomes a menace to the public. The poorly trained lawyer loses his client's case, and the public is warned by the evident lack of success on his part to avoid seeking his assistance in important matters. In so far as the interests of his client are interwoven with the interests of the community, he may do definite harm to the general welfare, but that is a blow to prosperity only, and because of the financial relation, the public is quicker to see and to act in the situation than where more subtle interests are threatened. The poorly trained doctor, however, not only fails to discharge his responsibilities to his patients, but is in a very real way a positive menace to the entire community. If he fails to recognize communicable disease and to take definite steps for its isolation, others must pay the penalty. The poorly trained man may be thoroughly honorable, and may strive to the utmost to discharge his own obligation, but if he has not the requisite knowledge, his most conscientious efforts are inadequate to protect the public. Consequently, every individual in the commonwealth is continually and vitally and personally concerned in the proper and thorough training of every man who practises the medical profession within its limits.

The state must get the proper standards of medical training from those who as its representatives are giving medical education in the state university in the name of the commonwealth, and the state must hold these teachers, its representatives, responsible that they set the standards of medical education carefully, so as to protect all its citizens from the consequences of poorly trained or inadequately trained or wrongly trained practitioners of medicine. Once that the medical school of the state university has established this standard and has applied it without fear or favor to its own students, the authorities of the state in legislative and administrative circles must for the protection of the commonwealth adopt and apply those standards not only to the students who receive training at the hands of the state, but to all persons who desire to enjoy the privileges of medical practise within the limits of the state. No nation could lay claim to membership in the group of progressive civilized communities that coined its own money on one standard and permitted private citizens to circulate money based on standards of their own choosing; and yet there are apparently intelligent commonwealths in our union that have seen one standard set for the education of professional men in their own universities, and have permitted private institutions to adopt other standards of their own making, to grant degrees of all sorts without regard for their actual value, and to turn loose upon the public professional men whose certificates of proficiency are no better than wild-cat banknotes. Nor is this establishment of standards by the state calculated to arouse resentment or opposition on the part of those private institutions which are seeking without regard to personal gain to discharge their obligations to the public. The very appreciation of such obligations and the renunciation of personal gain which enters into the legal organization of such institutions, make

them welcome the careful study of methods and standards by the state universities, since their own conditions often do not permit them to engage extensively in the investigation and solution of complicated educational problems.

It would be unfortunate for the commonwealth, however, if the entire energies of any college in its state university were expended upon the establishment of standards for proper training, and upon the application of those standards to a limited number of students. The state must look to the college for direction in those technical and professional matters that are entering more and more every year into the organization and development of our complex civilization. Municipal and state officers meet problems that they can not possibly solve without the advice and assistance of expert workers in various lines. There is a well-marked tendency to seek such consulting experts within the limits of the state university faculty; and where formerly men of no connection with the state or responsibility for the problem other than that indicated in the acceptance of a fee for a professional opinion, were summoned from a distance to solve the educational or engineering or hygienic problems of the community, to-day, states are looking for their help in determining the form of legislation, the principles of education or organization, and the methods of applied science in every field, to the universities that have been founded and developed at public expense. Such a tendency is not only natural but inevitable. There should be nowhere better trained and better informed men in any field than those who are called to serve the highest educational institution of the state in a particular line of work. There are nowhere men freer from bias, men more untrammeled by private influence or better calculated to resist insidious and insistent pressure, or men more devoid of other interests and more thoroughly devoted to the public welfare than those who have taken upon themselves the duties of teaching in the public university.

It is hardly necessary to take time to apply this principle in detail to the work of the medical college. Trained experts are nowhere more seriously needed and unfortunately also more difficult to secure than in the field of public health with its manifold relations to municipal sanitation and individual and community hygiene. Here it is that the research man justly maintains his preeminent position. If the water supply of a great city is contaminated, and the health of the entire community is threatened, it is the bacteriologist to whom municipal authorities rightly turn for information as to the precise source of the difficulty and advice as to the best methods of correcting it. If the exploitation of the public by unscrupulous purveyors of adulterated foods is to be prevented, a campaign must be based on the definite evidence which is furnished in the laboratory of the chemist. The public can not be protected unless it can assemble on its side a force of consulting experts and professional investigators whose training is broad enough and whose standing is high enough to enable them to compete successfully with the paid experts who can be summoned by great corporations and important interests and who by their partial exposition of the truth becloud the issue and protect the wrongdoer at the expense of the whole people. The state must have and must use the expert staff of its medical school in the service of the public.

There is a third function of the state professional school which I consider to be equally important, although less generally

recognized by the average man and woman because its meaning is more obscure and its relation to the ordinary affairs of life more difficult to demonstrate clearly. I mean the duty of the school as a center for continued research. The relation between highly trained men of the research type and the proper education of professional students is too clear to need extended demonstration. Standards can be set and applied only by those who have the broadest and strongest command of the professional situation. Then, also, the advice on technical problems which is to be furnished the state in time of need can come only from those who have themselves enjoyed the most thorough training and have demonstrated their ability as original workers in their individual fields. It is, however, equally essential that the professional school should be a center of continued experimental work. The discoveries of science that follow one another with such rapidity in these days must be tested, extended, applied, in order to have the maximum value for the race. The ability to test such discoveries depends very definitely upon acquiring, retaining and exercising the research habit. Unless a man keeps on investigating, unless he continues to experiment, he is not in a position to give the right value to a new discovery, or to place it in its correct relation to the other facts in his field, and to interpret it in a thorough and practical manner for the benefit of the community. The man who has devoted himself exclusively to teaching, or exclusively to the practise of his profession, whose entire mental energies are expended in carrying out his program of education, or in discharging his responsibilities to those who seek his advice and counsel, can not fully discharge his duties towards the state as the member of a professional faculty. As the delta of the river is gradually built up by the continued accumulation of myriads of minute particles, so the knowledge of one generation reaches a higher level by minute additions which come to it from a multitude of individual sources. If knowledge is to advance, and science to become more useful to the human race, if the life of to-morrow is to be richer and more varied than that of to-day, if the man of the future is to be freer from disease and more perfect in physical development, both individually and collectively, than the man of to-day, then every worker in the field of science must contribute at least his little part to the accumulation of new facts and new relations upon which in ultimate analysis this advance depends. The teacher who is adding to his knowledge only by the reading of that which has been acquired by others, is failing to cultivate a power that is of fundamental value to the institution and to the commonwealth. The expert who is merely repeating the work that he has done over and over again, who applies to every new situation only the methods and results of older experimenters, is not doing his part towards the institution he represents and the community that claims his service. It is not only true that the men who have contributed the great advances in knowledge have been those who applied themselves insistently to independent investigation, but also that the inspiring teachers and the efficient directors of public activity have been conspicuous for their devotion to research and their contributions to knowledge. Medical science is of recent growth. The application of discoveries in allied sciences to the cure and prevention of disease has yielded splendid results, but the work has only just begun and rich opportunities await the coming of new investigators. The welfare of the race demands

that the state do its part in cultivating this fertile field of research. Whatever private institutions may do, the state has no choice. The men who are its teachers must also be investigators and must contribute their share to the extension of knowledge.

I trust that my discussion thus far has not failed to call clearly before your minds the three features which I consider to be all-important in every university professional school. I hope that my brief statements have suggested to your minds the varied functions of the university teacher so clearly that you are ready to grant him the duties beyond those of the mere pedagogue. Routine teaching may be done equally well in any institution. Expert analysis and investigation, however, are limited to our great universities, because of their demands upon space and time and money. The state university which fails to take account of these duties, which loads its faculty members with teaching to such an extent that they have no time or energy left for other items, is not only doing itself a great injustice, but is false to its responsibilities to the state. Research opportunities should be provided for its staff, and research work should be demanded of each member. Provision for laboratory equipment and space are sometimes included in the plan of college organization when the specified duties of the instructor leave him no time or energy for the prosecution of research. Participation in meetings and conferences is important and may properly be demanded of the scientist in the service of the state, but unless due allowance is made for such activities in arranging the individual work of the teacher, unless he is given also some leisure for research, he will not contribute to the advancement of knowledge or to the protection of the state.

This, then, is the meaning of the new campus and the new laboratory. This, but the first building of a great group, is to be dedicated to the service of the state, with the fullest sense of the responsibilities which that service implies. But other buildings must follow to provide adequately for other lines of teaching, for it is no little work that is inaugurated this year on this new campus and in this first laboratory building. This institution is to furnish for the state of Nebraska to every one of its citizens and through them to the whole world by its teaching and investigation, richer possibilities for human existence. It is to establish here in the center of the great prairie region standards of medical education that will direct the advance in medical training, not only within its borders, but throughout all the surrounding states. It has gathered together here a group of trained experts who may reasonably stand unabashed in the company of any similar group in the great central west. It is to give them opportunity for directing public activity, for protecting public interests, for averting public disaster. They, as scientific men, know their responsibilities and appreciate their opportunities. They are ready to do their work, they are prepared to lead the state in achieving these greater results. They have already contributed to the advance of knowledge, they are eager to continue that work. They are demanding more, not for themselves, but that through it they may give more to the world. It is fortunate that the foundations of the enterprise have been laid in a city that has dreamed of other great possibilities and is realizing them. Equally propitious is the control exercised over its destiny by a great state, devoted to education and justly proud of its own university. Under such conditions, the vision must soon become a reality and other buildings rise be-

side this new structure to extend and multiply its work and to realize the hopes of other workers yet unprovided with adequate facilities, that here may be developed a great institution for the relief of suffering and the service of humanity.

HENRY B. WARD
UNIVERSITY OF ILLINOIS

THE SIGNIFICANCE OF THE NATIONAL BIRD LAW

FOR 125 years, constitutional lawyers and laymen were agreed on at least one thing—that the national government possesses only those powers specifically granted in the constitution, and those reasonably implied from such specific grants. The states possess the residue. There had been, it is true, some argument as to the interpretation to be given to Art. I., Sec. 8, Par. 1 of the constitution as well as to the 9th and 10th amendments. But this was wholly academic, and the consensus of opinion soon crystallized to the above stated proposition.

Yet during our constitutional life of 125 years we have seen remarkable changes going on in this country. The states were isolated and self-sufficient. The stage offered no inducement to travel from state to state, nor the pack horse to trade. To-day, what a revolution in our economic and social life! Railroads, steamships, the telegraph and telephone, along with a thousand other inventions, have made us live a different life. Distance has been shortened; the United States made smaller. One state can no longer satisfy our needs, for all states are interdependent.

Yet more remarkable than all, we live under substantially the same constitution. But only because it is too difficult to amend, for we are to-day confronted with many problems which some think can only be settled satisfactorily by a constitutional amendment. Yet that is next to impossible. It will pay us to glance at a few of the problems that have arisen because of revolutionary changes in our ways of living. For almost half a century the conflict of divorce laws in the states—some lenient, others strict—has been the subject of continual agitation. The origin of the American Bar Association and the origin of the Commission on Uniform State Laws is but an indication of the stir that the diversity in divorce laws must have produced. Yet in spite of continued attention to this subject from 1878, when the American Bar Association was organized, no substantial results have been accomplished; this, though the Commissioners on Uniform State Laws have fought for it for twenty-five years, though a national conference was held at Washington, and though no end of other organizations are urging uniformity of divorce laws. After all this effort three states have uniform divorce acts, and these are not absolutely uniform. The very natural result is that public opinion is turning to the federal government and asking for a national divorce law. But that would necessitate a constitutional amendment.

While not now in the public eye, it was only a short time ago that we heard of the evils flowing from the corporation laws of some states. And no wonder there was criticism when some of the states debauched themselves to an advertising campaign in order to induce incorporation under their laws, the "most liberal," that is the most lax, in the United States. Here too uniformity has been attempted by state action, and as yet not even an act has been agreed upon. Very naturally again public opinion turns to the national branch for relief, demanding either a federal incorporation act, a federal license, or any form of relief that federal action can give. Yet the constitutionality of such a law has been questioned.

In the various states, the progressive element is urging reform on such questions as hours of labor, woman and child labor, minimum wage, protection from machinery, protection from trade diseases, in short all the problems of modern factory life. What kind of opposition is met? A kind that is very difficult to reply to—successfully. The manufacturer says: "Yes, hours of labor should be reduced; children should not be employed; we ought to take greater precautions to protect

our employees; the situation does demand relief; but, however much we should desire all this, it is impossible if we are to continue in this business. We are met with a cold economic fact. Our strongest competitor against whom we can just hold our own [and every industry has such] lives in the state of X, which state is even now more lenient in its factory laws. If you accomplish this reform, you will ruin us. We could not compete under such unfavorable conditions. If you can force the state of X to pass similar laws, we heartily favor these very necessary reforms." And in state after state, year after year, has this type of argument defeated reforms that all felt were reasonable and desirable from every other standpoint. Some of our most progressive states will not listen to such argument, but eventually they must. What again is the result? The public is looking for a national child labor law, a national law for women, hoping to accomplish these reforms by an unwarranted interpretation of the interstate commerce clause. A constitutional amendment is necessary.

In this way the reader could be taken through a host of subjects in which a national law would solve the situation. Yet in each case such a law is either clearly unconstitutional, or constitutional only through some remarkable jugglery which the public to-day expects of the court, in view of the difficulty of amendment. To-day the commissioners on uniform state laws are considering or are urging uniformity in such questions as partnership, negotiable instruments, bills of lading, warehouse receipts, sales, stock transfer, workmen's compensation, taxation, insurance, carriers, conveyancing, acknowledging of instruments, the making and proof of wills as well as many other subjects. One might speak of the evils of double taxation or of the tangling question of situs in taxation; one might recall the insurance scandal in New York some years ago, the reforms put through in some of the states, and the agitation for a national insurance act; but the instances quoted show that quite a delicate situation exists. And in every case it is very unlikely that anything like real uniformity can be accomplished and permanently so by the voluntary action of the states. So that in each case a constitutional amendment would seem to be the only remedy, providing of course that the original and long-accepted thesis is true, namely that Congress possesses only conferred powers or powers implied from them.

Suddenly and almost unnoticed we have presented to us what looks like a solution of the whole difficulty. It is the theory lying back of the national bird law recently passed by Congress, and just being put into effect by the agricultural department, the so-called McLean Bird Act, regulating the killing of migratory and insectivorous birds. On what theory can such a law be constitutional? We shall see.

Almost daily we hear of the ravages of this or that insect. Now it is the San José scale, at another time the locust, sometimes the green leaf louse, and at another the potato bug. Nature has blessed us with an almost countless horde of insects which each year are causing tremendous damage to our crops. Experts have estimated this damage at various amounts. Dr. C. L. Marlatt, basing his estimate on statistics from the Department of Agriculture, concludes that an annual damage of 800 million dollars results. Mr. Forbush in his book, "Useful Birds," reaches the same conclusion. Whatever the damage may be is unimportant here; sufficient for our purpose that it is enormous. Likewise the experts have demonstrated that each of these ruthless insects has a natural enemy in the form of this or that bird. The claim very naturally follows that much of this damage can be avoided by encouraging the existence of the type of bird that feeds on the ravaging insects. The advocates of the national law declare that some states have failed to pass laws protecting such birds. For example one state protects robins and blackbirds, while another prefers to give to its inhabitants this source of food. These birds are migratory. What is the result? Protected in one state, and slaughtered in another. Any state that protects birds does so only to the advantage of another state, depriving its own citizens of this same source of food.

It "cuts its own throat" so to speak, by its own conscientiousness. This state will accordingly wipe out the prohibition, and so everywhere the law of the state with the most elastic conscience, becomes the law of all. One lenient state drags down all the others, for the laws protecting birds are competitive. So the birds die hard, and the hordes of insects go on multiplying and enjoying themselves at our expense. Up to this point there has been unanimity of opinion. From now we tread on doubtful ground.

Senator McLean, of Connecticut, believes that there must be an inherent right to protect oneself against this scourge. But where does this power lodge, in the federal or in the state branch? Senator McLean argues that the experience of 125 years, with diverse, spasmodic and crazy-quilt state laws has demonstrated their failure, and has proven conclusively that the power does not rest in the states. Their inability to efficiently protect birds and the consequent failure to reduce the insect pest, an experiment carried on for 125 years, shows that they do not possess this power. And somewhere, he contends, there must be lodged this power of self-protection. The states do not possess it; experience has so proven. There is but one alternative, the national branch. On this theory the national bird law was passed. The theory might be stated in the following form: "Whenever a particular power can not be efficiently exercised by individual state action, then that power is lodged in the federal branch. There need be no specific grant of power in the constitution, nor any implication from granted powers. The fact that diverse state action has failed proves it to be a federal power." When Senator McLean gave to the Senate the reasoning by which to uphold the constitutionality of a national bird law, to hold for migratory and insectivorous birds, the senators had great doubts; but as the reform was very necessary they passed the bill, shifting thereby a burden and possibly public criticism on the court.

A few excerpts from his speech of January 14, 1913, will state the legal reasoning by which the law is to be upheld. He said:

My contention is that congress has the implied power as a natural and necessary attribute of its sovereignty to provide for the common defense and general welfare of the nation whenever the need is general and manifest, and the subject is such that no state, acting separately, can protect and defend itself against the threatened danger or secure to itself those benefits to which it is justly entitled as a part of the nation.

If the state, by exerting its authority, can secure to its citizens the protection to which it is justly and fairly entitled, there will be no need of federal interference except as it may be complementary and at the request and with the approval of the state, but if the need for assistance is manifest, if the danger is real and general and it is not within the power of a single state to protect itself and secure the benefits and protection to which it is justly entitled, then there is, as it seems to me, no escape from the conclusion that the common defense and general welfare of the people must utterly fail unless the nation can come to the rescue.

Senator Borah declared:

I do not think that the constitution of the United States can be construed in the light of the negligence of the states. Simply because the states neglect to use their reserved powers constitutes no reason why the national government should assume to exercise unconstitutional powers.

At another point Senator McLean said:

I frankly said that I did not myself find authority for it [the national bird law] in any express clause of the constitution, but I thought it was one of the implied attitudes of sovereignty, based upon the incompetency of any state to accomplish the results desired, and that it is absolutely necessary that any nation worthy of the name shall have this power.

Senator McLean could cite no decision in point on this novel theory. Yet the same theory has been urged before and has been by some called the Wilson rule of construction. In 1785 James Wilson used language applicable to our constitution, though the argument was then made under the Articles of Confederation. He said:

Though the United States in congress assembled derive from the particular states no power, juris-

diction or right which is not expressly delegated by the confederation, it does not then follow that the United States in congress have no other powers, jurisdictions or rights, than those delegated by the particular states. The United States have general rights, general powers and general obligations, not derived from any particular states taken separately; but resulting from the union of the whole. To many purposes the United States are to be considered as one undivided, independent nation; and as possessed of all rights, powers and properties by the law of nations incident to such. Whenever an object occurs, to the direction of which no particular state is competent, the management of it must, of necessity, belong to the United States in congress assembled. There are many objects of this extended nature.

In one of his speeches, after a few complimentary words for James Wilson, Mr. Roosevelt said:

He developed even before Marshall the doctrine (absolutely essential not merely to the efficiency but to the existence of this nation) that an inherent power rested in the nation outside of the enumerated powers conferred upon it by the constitution, in all cases where the object involved was beyond the power of the several states, and was a power ordinarily exercised by sovereign nations. . . . Certain judicial decisions have done just what Wilson feared; they have, as a matter of fact, left vacancies, left blanks between the limits of actual national jurisdiction over the control of the great business corporations. Actual experience has shown that the states are wholly powerless to deal with this subject [control of corporations] and any action or decision that deprives the nation of the power to deal with it simply results in leaving the corporations free to work without any effective supervision.

One might quote no end of decisions and texts declaring that Congress has only conferred and implied powers. Until this act the proposition has been regarded as settled. Therefore only one very recent case will be cited. In the case of Kansas *v.* Colorado, 206 U. S. 46, 1907, the same argument as that underlying the bird law was presented, and the court by Justice Brewer replied:

But the proposition that there are legislative powers affecting the nation, as a whole, which belong to, although not expressed in, the grant of powers, is in direct conflict with the doctrine that this is a government of enumerated powers. That this is such a government clearly appears from the constitution, independently of the amendments, for otherwise there would be an instrument granting certain specified things made operative to grant other and distinct things.

He then shows it to be conflicting with the 10th amendment, which declares:

The powers not delegated to the United States by the constitution, nor prohibited by it to the states, are reserved to the states respectively, or to the people.

This means that in the ordinary way—constitutional amendment—this new power could be thrown into the federal sphere, but in no other way can it be accomplished.

Constitutional thought then would seem to be unanimous against the validity of the McLean law, although there is "a" theory on which it might be vindicated. Public opinion is quite interested in a national bird law, and naturally hopes for a favorable decision.

What will be the effect of a decision declaring valid this new type of national powers, never before exercised. It will mean that Congress can legislate on any subject in which uniformity is desirable but impossible by diverse state action. It will open the way for a federal divorce law, a federal marriage law, a federal incorporation law, a federal insurance law, federal laws regulating hours of labor and the conditions of labor, federal laws on negotiable instruments, bills of lading, warehouse receipts, partnership, in fact the whole list of subjects which is now being urged upon the states for uniform adoption. It is conceivable too that after Congress has once legislated on such a subject, conditions may change, and uniformity become undesirable. Would it not follow then that the particular power would again be shifted to the states, and could not be constitutionally exercised by the federal branch? It is apparent that this new doctrine would virtually wipe out our whole division of powers between the state and federal branches, and would erect in its place a shifting rule depending on economic conditions. It would virtually destroy our constitution as far as the division of powers is

concerned, for there might just as well be no constitutional provision on such subjects. The courts too would have a delicate task, for they must decide whether uniformity is desirable, and second whether state action has produced an efficient result—both of which would be social, economic and political rather than legal questions; and on both of these hardly two people will agree. One can see the new field of legislation that this new theory opens up. It would make our constitution as elastic as the English constitution as far as the division of powers is concerned. It would revolutionize our whole constitutional growth. An early decision by the Supreme Court of the United States is then to be looked forward to with great interest both by the public and by students of law and government.

RAYMOND THEODORE ZILLMER

AMERICAN PHILOSOPHICAL ASSOCIATION

THE thirteenth annual meeting of the American Philosophical Association will be held at New Haven, Conn., on December 29, 30 and 31, in acceptance of the invitation of the Philosophical Department of Yale University. The sessions will begin on the afternoon of the 29th. The American Psychological Association will also meet at New Haven at the same time, and there will be one joint session of the two Associations.

The subject for consideration in this joint session is "The Standpoint and Method of Psychology." At the present time it is still uncertain whether this session will be devoted wholly to discussion of this subject, or whether a varied program will be made from among the papers offered, of a few of those that promise to be of greatest interest.

By a resolution adopted at its last meeting the Philosophical Association is this year committed to the discussion of some important problem for two sessions. This will give opportunity for both the opening papers and a subsequent adequate consideration of the subject chosen. The question selected for this main discussion is the problem of the relation of existence and value, including their relation both as facts and as concepts, and also the relation of a theory of existence to a theory of value.

E. G. SPAULDING,
Secretary

PRINCETON UNIVERSITY

AMERICAN SOCIETY OF ZOOLOGISTS

THE American Society of Zoologists, in affiliation with the American Society of Naturalists, the American Society of Anatomists and the Federation of American Societies for Experimental Biology, will hold a joint meeting of its eastern and central branches at Philadelphia from December 29 to January 1.

A joint meeting of the two branches of the Society is held this year in order that the report of the "Committee on organization and policy" may be considered and voted upon. This committee, consisting of E. G. Conklin, G. A. Drew and R. G. Harrison, representing the Eastern Branch; F. R. Lillie, M. M. Metcalf and W. A. Locy, representing the Central Branch, and the president of the society, *ex officio*, was appointed at the Princeton meeting and instructed to report at the meeting held in Cleveland. At the Cleveland meeting no report was received and the society continued the committee. On August 15, 1913, a meeting of the committee, called by Professor H. B. Ward, president of the society, was held at Woods Hole, at which a constitution for the society was outlined and agreed upon. At this meeting Drs. Lefevre, Reighard and Parker were invited to meet with the committee and take part in the deliberations, thus filling temporarily the places of members of the committee not at Woods Hole. The draft of the constitution formulated at this meeting was later sent to all the members of the original committee by the chairman, Dr. G. A. Drew, and certain changes and additions agreed upon have been made.

Since this meeting falls in eastern territory, the eastern branch will act as host, and, as required by the constitution, the officers of the eastern branch will be responsible for the program and other necessary arrangements. Members of both branches should, therefore,

send titles of papers to the secretary of the eastern branch. If possible, abstracts not exceeding two hundred words should be forwarded at the same time as the titles of papers. *In no case will abstracts be received later than the date of the final adjournment of the coming meetings.* Members are requested to indicate the group to which their papers belong in such a scheme as is here given: (1) Comparative Anatomy; (2) Embryology; (3) Cytology; (4) Genetics; (5) Comparative Physiology; (6) Ecology; (7) Miscellaneous Subjects.

The last session of the Zoologists will be held on Thursday, January 1. The meetings of the Naturalists are planned for Wednesday, December 31. The Naturalists' dinner will be given on Wednesday evening.

CASWELL GRAVE,
Secretary Eastern Branch
JOHNS HOPKINS UNIVERSITY,
BALTIMORE, MARYLAND

THE SIGMA XI CONVENTION

THE fifteenth convention of the society will be held at Atlanta, Georgia, on Tuesday, December 30. It is proposed that the delegates to the convention have luncheon at one o'clock, followed by the meeting for the transaction of business. In the evening there will be a dinner for members of the society and their guests.

By the rules of the society the convention is held at the time and place of the meeting of the American Association for the Advancement of Science unless otherwise provided for by the officers of the society. In view of the distance of Atlanta from the larger scientific centers, the question was submitted to the members of the council. Twenty-nine voted to meet at Atlanta, two to hold the meeting elsewhere or not at all, and three were doubtful.

There is every reason to believe that a successful meeting for the transaction of business will be held at Atlanta. Members of the council who have been influential in the development of the society have expressed their intention to be present, and it may be expected that the chapters will be adequately represented by their delegates. As the scientific programs of the American Association for the Advancement of Science and the affiliated societies will be less crowded than usual, the convention will have time to consider the important questions that will be brought before it.

DELEGATES TO THE CONVOCATION WEEK MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

AT the Cleveland meeting of the American Association for the Advancement of Science, a committee was appointed to address a letter to educational institutions, government bureaus and other agencies engaged in scientific research, requesting them to send one or more delegates to the annual convocation week meetings of the American Association and the affiliated societies. This committee, which consists of Professor Charles S. Minot, chairman, Harvard Medical School; Professor J. McKeen Cattell, Columbia University, and Dr. L. O. Howard, the permanent secretary of the association, has addressed to a list of institutions the following letter:

At the meeting of the council of this Association, held in Cleveland, Ohio, on January 3, 1913, the following resolutions were adopted:

1. *Resolved:* That the Council of the American Association for the Advancement of Science requests the educational institutions, government bureaus and other agencies engaged in scientific research to send one or more delegates to the annual convocation week meetings of the Association and its affiliated societies, and that when possible the traveling expenses of the delegates be paid by the institutions which they represent.

2. *Resolved:* That a committee of three be appointed by the chair to draw up a list of institutions to which this resolution, together with a suitable letter, shall be sent by the permanent secretary.

The undersigned, in accordance with the above resolutions, were appointed as the committee called for, and we have the honor to invite your institution to send one or more delegates to the next meeting of the American Association for the Advancement of Science which will be held at Atlanta, Georgia, December 29, 1913, to January 3, 1914. We believe it will be of substantial benefit to your institution to be thus represented at our meeting. A considerable number of affiliated so-

tional scientific societies will meet together with the Association, which thus becomes a national congress, at which all the most important work and the most important problems of science and scientific education are adequately discussed. The paying of the expenses of delegates is not an innovation, as it is already the custom of several institutions, and in Europe it is the general custom, owing to the belief that the sending of official delegates to important scientific meetings is of great benefit to the institutions they represent.

Members of the association are requested by the committee to use their influence to secure the appointment of delegates from the institutions with which they are connected.

SCIENTIFIC NOTES AND NEWS

DR. BOOKER T. WASHINGTON, principal of the Tuskegee Industrial Institute, Alabama, extends a cordial invitation to the members of the American Association for the Advancement of Science and of the affiliated societies to visit the institute at the close of the Atlanta meeting.

A PORTRAIT of the late Dr. Morris Loeb, formerly professor of chemistry at New York University, was unveiled in the Gould Memorial Library at New York University on December 4. Mrs. Loeb, who presented the portrait, was present at the exercises, and Chancellor Elmer E. Brown accepted the gift in behalf of the university. Speeches of tribute to Dr. Loeb's memory were delivered by Dr. Arthur E. Hill, director of the Havemeyer chemical laboratory, of New York University, and Professor Charles Baskerville, director of the laboratory at the College of the City of New York.

THE Grashof Medal was presented to Mr. George Westinghouse at the recent meeting of the American Society of Mechanical Engineers. The medal was awarded to him last summer at the joint meeting at Leipzig of the American Society of Mechanical Engineers and the Verein Deutscher Ingenieure.

ON the evening of December 17, the faculty of Brown University will give a dinner to Professor John H. Appleton, Newport-Rogers professor of chemistry, who this year completes fifty years of service. Professor Appleton began teaching at Brown University at the unusually early age of nineteen.

DR. SHOSUKE SATO, professor and dean of the Agricultural College of the Tohoku University, has been designated as exchange professor at the American universities. He was a student of agricultural economy at Johns Hopkins University and also in Germany from 1882 to 1886.

PROFESSOR A. A. NOYES, of the Massachusetts Institute of Technology, will during the second semester of the year conduct courses and give lectures in chemistry at the Throop College of Technology, Pasadena, Cal.

MAJOR F. F. RUSSELL, formerly professor of bacteriology and pathology at the Army Medical School, Washington, D. C., has been appointed lecturer in tropical medicine at the New York Post-Graduate Medical School and Hospital. Major E. R. Whitemore, recently lecturer in tropical medicine at the Post-Graduate Medical School, has been transferred to Washington, and is now professor of bacteriology and pathology at the Army Medical School.

CAPT. J. F. SILER, of the Medical Corps of the United States Army, and Mr. A. H. Jennings, of the Bureau of Entomology, Department of Agriculture, have recently returned from the West Indies, where, in association with Dr. Louis W. Sambon, of the London School of Tropical Medicine, they have been investigating pellagra and other tropical diseases in the interests of the Thompson-McFadden Pellagra Commission of the New York Post-Graduate Medical School and Hospital.

M. JEAN PERRIN, professor of physical chemistry at the University of Paris and at present exchange professor at Columbia University, gave an illustrated lecture on December 4, on "Brownian Movement and Molecular Reality" at a joint meeting of the Washington Academy of Sciences and the Philosophical Society of Washington.

DR. MAX PLANCK has been installed as rector of the University of Berlin and gave on the

occasion an address on "New Paths of Physical Research."

Professor J. Chester Bradley, of Cornell University, addressed the New York Entomological Society on December 2 on "Collecting Insects in the Okefenoke Swamp." Professor Bradley was one of several Cornell zoologists who began a biological reconnoissance of the Okefenoke Swamp in southeastern Georgia in the summer of 1912. He again visited the swamp during the past summer, and in company with Dr. J. G. Needham will return for a short stay next month. A preliminary account of the features of the swamp in connection with a report on the ornithology of the expedition was published by Dr. A. H. Wright and Mr. F. H. Harper in the *Auk* for October, 1913.

Professor H. C. Jones, of the Johns Hopkins University, delivered an illustrated lecture on "Radium and Its Properties" Tuesday evening, December 2, before the Natural History Society of Harrisburg, Pa.

Mrs. Christine Ladd-Franklin held a conference on Color-Vision on December 6 at the Brooklyn Academy of Music.

An interesting program is already assured in connection with Section E, Geology and Geography, of the American Association for the Advancement of Science, at the approaching meeting in Atlanta. The mineral resources of the south will be fully presented by means of papers, maps and mineral exhibits by the geologists of the southern states. The program also includes papers of general geological interest. The titles and abstracts of papers to be read before Section E should be sent at once to Professor George F. Kay, Iowa City, Iowa.

The power schooner *Mary Sachs*, one of the boats of Mr. Vilhjalmar Stefansson's Canadian Arctic exploring expedition, has been wrecked in the ice off the Arctic coast of Alaska. The ice crushed the schooner and all the provisions and scientific instruments were lost. The *Mary Sachs* was purchased at Nome by Mr. Stefansson for use of the southern party of the Canadian expedition, which also has the power schooner *Alaska*. Dr. R. M. [illegible], commanding the southern party, [illegible] the *Alaska*, and Mr. Kenneth Chip[illegible], the geologist, was placed in command of the *Mary Sachs*. The last previous report received from the expedition was carried by messenger to Circle City, Alaska, arriving there November 10. The messenger reported the *Mary Sachs* and the *Alaska* ice-bound at Collinson Point, Alaska, one hundred miles west of the international boundary. The *Mary Sachs* was a gasoline schooner of 350 tons gross register. She carried a crew of three men. The southern party was to have made a scientific exploration of Victoria Land and Banks Land, while Mr. Stefansson on the *Karluk* explored the unmapped region in Beauford Sea.

The American National Red Cross announces the receipt of gifts of $100,000 each from Mr. Jacob H. Schiff and Mr. James A. Scrymser, and of $2,000 from Mrs. Whitelaw Reid. The gift from Mr. Scrymser is to be added to the fund for the purchase of land in Washington on which the government is to erect a building for the Red Cross as a memorial to the women of the Civil War. Congress has already appropriated the sum of $400,000 to cover the cost of constructing the building, and the Red Cross has offered to raise the $300,000 necessary for the purchase of the land.

Closer union between the state board of health and Ohio State University and its departments of instruction is contemplated in the proposal to move the state laboratories to the university campus. A detention hospital for the wards of the state will also be built there and public health conserved by university service. The proposition was endorsed at a recent meeting by the board of administration, the state university trustees and Governor Cox. It is believed that the plan will reduce the expense of operating the state board of health laboratories, afford practical work for students in the preparation of serums and the making of experiments, and enlarge the efficiency of the state in its relation to public health. Governor Cox also endorses

the proposal to move the state library to the campus.

THE daily life of the ancient cliff dwellers is exhibited in the new permanent "Southwestern Indian Hall" just added to the museum of anthropology of the University of California, in San Francisco. Two other phases of aboriginal life are abundantly illustrated in the same new hall—the town-dwelling arts, crafts, rites and industries of the Pueblo Indians, and the life of war and the chase led by the nomadic tribes of the Southwest, such as the wild Apaches, Navajos, Pimas, Papagos and Walapais. The museum is open free to the public daily except Monday, with free lectures every Sunday at 3. It has four other large permanent exhibition halls—Egyptian, Greek, Peruvian and Californian—besides smaller unit collections. The collections of this museum of anthropology are said to be worth from three to five million dollars. They are the gift to the university of Mrs. Phoebe A. Hearst. The department of anthropology is extending its usefulness by field investigations of Indian languages and customs, by correspondence courses in anthropology, and by sending out to any school that desires traveling loan collections illustrating life among the Indians.

AT the meeting of the Academy of Natural Sciences of Philadelphia, held the 2d inst., the following was unanimously adopted:

WHEREAS, The academy has been informed by the council of the receipt and adoption of a final report on the centenary celebration and the discharge of the committee having charge of it,

Resolved, That the academy, approving of the action of the council, desires to express its obligation to the committee and to record on the minutes its thanks for the entirely adequate and satisfactory discharge of its duties, resulting in a record of achievement which can not fail to be an incentive to those who will celebrate the second centenary of the academy in 2012.

BULLETIN 539 of the Harvard College Observatory, signed by Dr. Edward C. Pickering, the director, states that Titan, the brightest satellite of Saturn, has been found to be variable from a discussion of observations taken on 60 nights by the late Oliver C. Wendell. The measurements were made with the 15-inch equatorial as described in H.A. 69, Part 1. The light varies regularly from 8.53 to 8.77, when reduced to mean opposition. The average deviation of twelve groups from a smooth curve is ± 0.023. The period as in the case of the eighth satellite, Japetus, is the same as that of revolution. Accordingly, it is probably due, in both cases, to one side of the satellite being darker than the other. Titan is fainter than its mean brightness for only about one third of the time. The minimum occurs near the times of superior conjunction. From similar observations, on 96 nights, Japetus was found to vary from 10.40 to 12.18. The maximum brightness occurs very near the western elongation.

THE study of protective coatings for iron and steel, begun by the American Society for Testing Materials in 1903 and continued unbrokenly and with increasing effectiveness to the present time, is described in detail in the reports of Committee E (now Committee D-1), now published in combined form in a single volume by the American Society for Testing Materials. During the first few years of the committee's work, it had more or less to feel its ground, but as soon as definite lines of work became clear to it, this work was taken up and pushed as vigorously as possible, consistent with the exercise of conservative judgment. The first constructive work the committee undertook was in the application of nineteen different paints on the Havre de Grace bridge in 1906. Since then a great deal of work has been accomplished in the study of white paints, the influence of pigments upon corrosion, linseed oil, soya bean oil, China wood oil, turpentine, definitions of terms used in paint specifications, etc. There is probably no book which contains within its covers so much original work on the subject of paints. Committee D-1, approximately made up, as it is, half of representatives of producing interests, and half of representatives of consuming interests, constitutes a body of investigators, unhampered as to any line of investigation it

may take up, but conservative as to the conclusions it draws. The volume is arranged chronologically, and the contents give full information as to where the reports of the various subcommittees appear. These reports contain numerous tables giving analyses and classifications of paint materials.

UNIVERSITY AND EDUCATIONAL NEWS

At the meeting of the National Association of State Universities, which was held recently in Washington, D. C., a committee was appointed to draw up plans and policies to be submitted to congress for its approval. A bill will be presented asking for $500,000 as the first step in the organization.

A fund of $500,000, which the Knights of Columbus of this country have been collecting for more than two years for the Catholic University at Washington, has been completed. The gift, it is understood, will be presented to the institution some time during the Christmas holidays.

The board of regents of the University of California has announced the completion of the additional fund of $600,000 for the erection of the hospital building which is to be a part of the College of Medicine of the university. It is stated that the principal donations to the fund are from Mr. and Mrs. William H. Crocker, Templeton Crocker and Mrs. C. B. Alexander, New York, who contributed $150,000, and Mr. John Keith who also gave $150,000. A committee has been appointed to administer the fund and supervise the erection of the building.

The library of the late Dr. Ernest Ziegler, professor of pathology at Frieburg, founder of the *Beitrage zur Pathologische Anatomie* and author of the well-known text-book on pathology, was presented formally to the medical department of the University of Pittsburgh on December 4. The donor is Mr. Richard B. Mellon of Pittsburgh.

Faculty promotions at Oberlin for the coming year include: Robert A. Budington, associate professor of zoology, to be professor of zoology and head of the department; Dr. George R. M. Wells, instructor in psychology, to be associate professor; Dr. S. P. Nichols, associate professor of zoology. New appointments include: Dr. Charles G. Rodgers, to be professor of zoology. Dr. Rodgers's academic record is as follows: A.B., Syracuse University, 1897; A.M., Syracuse, 1899; Ph.D., California, 1904; instructor in zoology, Syracuse, 1899–1902; assistant professor, 1902–07; associate professor, 1907–11, and professor since 1911.

New members of the staff of instruction of the Throop College of Technology are Franklin Thomas, B.E., Iowa, associate professor of civil engineering, and Howard J. Lucas, B.A., Ohio State University, M.A., Chicago, instructor in chemistry in place of Charles A. Brautlecht, resigned. Professor Thomas has done graduate work at McGill University and has been a member of the engineering staff at Michigan. He has also had practical experience.

DISCUSSION AND CORRESPONDENCE

MORE DATA ON THE HISTORY OF THE DOLLAR MARK

Private correspondence carried on since the publication of my article on the evolution of the dollar mark in the *Popular Science Monthly* for December, 1912, has brought to my attention some new material and a few minor corrections, which seem worthy of publication. I may say at the outset that the new material does not modify the conclusion I had reached, viz., that the modern dollar mark descended from p^s, the Spanish-American abbreviation for "pesos." As a first correction, my former statement that in Argentina, $ is placed after the numerals, thus 65 should be modified by inserting "usually" or "frequently." In the newspaper *La Prensa*, published in Buenos Aires, the $ usually follows the numerals in the short advertisements, but usually precedes the numerals when they are arranged in columns. Again, I said that the $ occurred in the Hawaiian edition of 1845 of Warren Colburn's "Mental Arithmetic," but the corresponding secretary of the Hawaiian Historical Society kindly informs me that the

edition of 1835 contains the \$ and that there was a still earlier edition which he had not seen. I had stated that, in 1802, William A. Washington used the \$; Mr. E. Tobitt, of the Omaha Public Library, informs me that an original ledger of George Washington himself, owned by the library, contains the \$ frequently. The earliest date of the ledger is January 1, 1799. It would be interesting to receive reports about older Washington ledgers on this point.

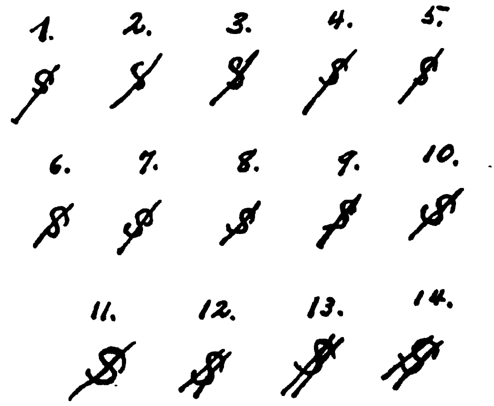
Of value, by way of corroboration of our conclusions, is the following quotation from a letter of Professor H. E. Bolton, of the University of California. He says:

> I see that your conclusion is just what mine was, with the difference that yours is based upon wide research, in different languages, while mine was based upon incidental observations in connection with work on Spanish manuscripts.

Most interesting information relating to the early use of the dollar mark is contained in a letter which I received recently from Mr. Augustus H. Fiske, of Cambridge, Mass. Mr. Fiske points out that the modern dollar mark occurs in a diary of Ezra L'Hommedieu for the year 1776. This date is two years earlier than the earliest occurrence of the modern dollar mark that is mentioned in my article in the *Popular Science Monthly*. Mr. L'Hommedieu was a native of Southold, Long Island. After graduating from Yale he practised law in New York City. He was a member of the New York Provincial Assembly which, on July 10, 1776, styled itself the Convention of the Representatives of the State of New York. During a portion of his service he kept a diary stating what took place in the assembly. This is still in the possession of his descendants. The first date mentioned in the diary is June 10, 1776. It ends abruptly on December 5, 1776.

Before August 21, 1776, most of the sums of money mentioned in the diary are expressed in pounds and shillings. When dollars are mentioned, the word "dollars" is written out in full. On August 21 occurs the first use of the dollar mark in the diary (see tracing 1). I quote the following from Mr. Fiske's letter:

> The item reads, Treasurer to advance to Capt. Wisner \$580 for bounty. On P. M. Aug. 24th. Hugh Doyle is to receive 8 dollars. Here the word is spelled out once more. Meanwhile English money continues in other items. Under date of A. M. Aug. 28th. the treasurer is to advance \$10 for removing military stores from N. Y. Here we have the second occurrence of the \$ sign (tracing 2).
>
> During the next few weeks appropriations in dollars become more frequent, though the English money still predominates and the dollars are still spelled out. On A. M. Octr. 2d, a loan of \$100,000 is obtained from the Continental Congress (tracing 3), and on Oct. 3d and 4th the same sum is referred to in a similar way (tracings 4 and 5). On the latter date the treasurer is also to pay \$6412 2/3 bounty money to the rangers (tracing 6). The \$ sign now appears more frequently. On Octr 11th both A. M. and P. M. it appears in reference to the loan of \$100,000 and an advance of \$200 to the troops of Orange County (tracings 7 and 8); and the \$100,000 again appears on Octr. 14th A. M. (tracing 9).
>
> Meanwhile references to English money continue, but only one to dollars, written out, on A. M. Oct 15th. That same day \$10,000 was appropriated to buy clothing for the troops (tracing 10), and the next morning \$100 was given to encourage the manufacture of flax (tracing 11).
>
> The next two weeks contain fourteen items of



> English money and it is not till P. M. Octr. 31st that Uriah Mitchell applies for cash on account of wages as a daily rider and received \$100 on account (tracing 12). The appropriation was approved the next morning and referred to as \$100 (tracing 13). English money is now referred to until P. M. Nov. 9th when E. Benson Esqr., is to

apply to the General Court of New Hampshire for $1000 (tracing 14). Thereafter until the end of the book the money is all in English pounds.

We see in the above the gradual substitution of the conventional $ sign for the spelled word. The spelling out of the word becomes less and less frequent as the record proceeds. If we examine the tracings of the signs, we find that the first eleven have the S crossed by only one line. The last three have the double line as it is used at the present day.

Florian Cajori

Colorado College,
Colorado Springs, Colo.

A NON-CHROMATIC REGION IN THE SPECTRUM FOR BEES

To the Editor of Science: The brilliant work of Professor K. v. Frisch, of Munich, on the color sense of bees (which follows upon his very ingenious investigation of the color sense of fishes and of crabs) seems to have been strangely overlooked in this country, where more confidence is placed in the very insufficient (from the point of view of logic) conclusions of Hess than they deserve. v. Frisch carried on his experiments on bees in the open air, in the close vicinity of an aviary; he found that a single day's training was sufficient to enable many hundreds of bees to form the association: Whatever is blue is sweet, whatever is gray (of any one of thirty-two different shades) is not sweet. In the same way they were able to learn, later, that yellow indicates sweetness; no amount of training, however (they were tried steadily for ten successive days), could teach them to distinguish between red and black. Training for green had to be postponed for another year, on account of the oncoming of the cold and rainy weather of autumn, which rendered the bees too sluggish to carry on the work.

Professor v. Frisch's results are so striking, especially the proof of the total blindness to red of his bees (shown already by Washburn and by Watson in the case of higher animals), and his method (which I do not give here) was so good—so convincing and so little consumptive of time—that I was anxious to have him, when the weather permitted, put to the test a question which had been in my mind for some time, namely, whether, when animals are insensitive to red, there can not be found a certain blue-green (its complementary color) to which they are also insensitive—whether they have not, in other words, a dichromatic (yellow and blue) color system only. I therefore wrote to Professor v. Frisch some three weeks ago on this point, and I have now received a reply from him. He writes me that he has already tried the experiment, and that my *Vermuthung* is justified. There is a completely non-chromatic region for the bee in that part of the color-spectrum which corresponds to blue-green for the normal eye: no amount of training enabled the bees to pick out this color from the series of grays, although, as I have said, a single day sufficed to train them to alight, in hundreds, on yellow, or on blue, and to leave the grays entirely unvisited. This, combined with the fact that the point of maximum brightness for bees is shifted well towards the green (the circumstance which led Hess to the erroneous conclusion that bees, as well as all other invertebrates together with fishes, are insensitive to chroma—that they have achromatic vision only) shows in fact that their vision is dichromatic instead of tetrachromatic, that their colors are yellow and blue, and that their vision resembles in type the protanopic form of red-green blindness.

That this quite extraordinary fact—the non-specific quality to bees (as well as to fishes) of the blue-greens—has not hitherto been discovered by the investigators of the color sense of animals is easy to understand, for, since one can not readily try all the colors of the rainbow, one naturally tries first the "unitary" colors, red, green, yellow and blue; instead of the "color-blends," blue-green, yellow-green, red-yellow and red-blue (the two last are popularly but most unscientifically called orange and purple, respectively). One forgets, what ought to be a perfectly familiar fact, and would be were it not for the innumerable color-illusions which the Hering color-theory forces upon its adherents, that though the red-green blind individual never

gets the sensation *green*, it is not the chlorogenic light-rays (*i. e.*, those which produce for us the pure green sensation) that are achromatic to him, but that it is exactly the "blue-green"-producing light-ray region to which he is wholly chroma-blind. This is a hard saying for the adherent of the Hering theory: one of the many logical *voltes-face* which he is obliged to perform, in order to follow his leader, is to believe at one moment that red and green are complementary colors (which every kindergarten child knows they are not),[1] and to admit at the next moment that the mid-spectrum region which gives an "achroma"-sensation to the partially color-blind is not green but blue-green. This latter fact demands (and receives) countless most complicated purely *ad hoc* hypotheses by way of explanation on the part of the adherents of Hering (or so many of them as have recognized its damaging character).[2] In my color theory[3] this fact is a matter of course—it is one of the facts which the theory was devised for the purpose of taking account of.

Our shockingly inadequate color-language does not readily permit us to state—and hence still less to remember—that objective light-rays of a given periodicity are not in themselves, *e. g.*, "green," but only a cause of a green sensation, in a normal eye, after their effect on the retina has been transmitted to the cortex. What looks pure[4] green to a person with normal vision will look pure yellow to the partially color blind, with equal justification—a fact which is quite destructive to the Hering theory. We have here good proof that it is important to have a reasonable color-theory in the back of one's mind, or at least not to have an unreasonable one. Those who maintain that color-theories are, in the present stage of our knowledge, of no consequence are those who are nevertheless, subconsciously, fully dominated by the Hering theory. They will tell you, for example, that the brightness of the most brilliant of reds is wholly due to its whiteness, quite as if they were making, not a wildly improbable theoretical statement, but a plain statement of fact. One of them said to me lately, "But I can not think of red and green as anything but complementary colors!" No physicist, of course, can give a moment's attention to a theory which flies in the face of fact to this extent. On the other hand, the open-mindedness to psychological considerations which the physicist is sure to develop some time is already evidenced in a phrase lately dropped by Robert Wood (in his wonderful book on "Physical Optics"); he speaks of an even red and green light-mixture as producing "subjective yellow." This is probably the first time that any physicist has ever found occasion to admit that though red, green and blue spectral lights, if mixed, will furnish matches for all the intervening colors of the spectrum, it still needs to be explained that the series matched by the red-greens contains, for sensation, no trace of red-greenness. Helmholtz himself said that the yellowness of red-green, and the whiteness of red-green-blue were quite immaterial circumstances.

J. B. and M. L. Watson, reporting on their work on the specific light response of some rodents, in which they seemed to find that the rat does not discriminate between red and green, nor between blue and yellow, say: "To the adherents of color theories the denial of a response based upon wave-length, in the case of red and green, and in the case of blue and yellow, is the equivalent of denying the possibility of a response on the basis of wave-length anywhere in the animal's spectrum." But this view is an indication that all theories look alike to them. On my theory, which was devised for the purpose of taking account of the *facts* of

1 Hering himself has explained to me that color does not mean much, because colors vary so with the illumination!

2 See G. E. Müller in the *Zeitschrift für Psychologie*, Bd. XIV., and passim.

3 See Baldwin's "Dictionary of Philosophy and Psychology," Art. Vision, and the "Psychology" of Professor Calkins, who has now relegated both Helmholtz and Hering to an appendix. My theory has lately been appropriated by F. Schenck. v. Brücke, *Zntrlb. f. Physiologie*, 20, No. 23.

4 That one can perfectly well form this judgment "imitary color," "color-blend," has lately been shown by Westphal, *Ztsch. f. Psychol.* (1), 44, p. 182, 1909.

color vision, it is exactly an even blue-green, which looks to the yellow-blue visioned individual achromatic. In this case, of course, there was no occasion for trying blue-green, since the rats could not be shown to have any color sense at all—a result which there are several reasons for having anticipated. Nevertheless, it remains true—what v. Frisch's discovery confirms—that you can not, as a matter of fact (nor in my theory), draw simple inferences from the unitary colors to the color-blends.

Professor v. Frisch has sent me specimens of the blue-greens to the chroma-quality of which his bees are insensitive; I should be glad to share them with any one who can proceed to test the blue-green sense of any animals which are already known to be blind to red.

CHRISTINE LADD-FRANKLIN
COLUMBIA UNIVERSITY,
November 7, 1913

NOTES ON A CHESTNUT-TREE INSECT

WHILE in the employ of the Pennsylvania Chestnut Tree Blight Commission, last winter, my attention was called to numerous burrows almost always present in the bark of the chestnut tree, particularly in the smooth-barked trees. These are the burrows that Metcalf and Collins referred to in the U. S. Farmers' Bulletin, No. 467, as the work of *Agrilus bilineatus*. As we were sure the burrows were not made by this species, the commission force referred to the insect maker as the *Bast Miner*. Not much was accomplished on the study of this insect until the spring season advanced. Then much effort was directed to the solving of the life-history of this insect and what relation it bore to *Endothia parasitica*. When the work stopped in July, the life-history was nearing completion, and a number of experiments were in progress which would have given some interesting results. A detailed account of the description of the larva and its work, etc., was prepared for publication, but the only adult obtained was injured irreparably and probably can not be named. Because the adult insect emerged after July 1 (the time of my leaving Pennsylvania), it has been impossible to work out the egg-laying habits. The larvæ hibernate in the burrows in either the second or third instar. During the winter months they are inactive, but, as soon as spring opens, activity commences. When finished, the burrow is not very extensive, the longest not being more than six inches and extending longitudinally. In width, it extends only over a very short distance.

While the insect is living within the trees, the burrow can not be detected externally. After the emergence of the larvæ, however, the bark swells over the burrow, often cracking and making a conspicuous wound. The larvæ leave the trees during the first part of June through minute exit holes, dropping to the soil, in which they spin a seed-pod-like cocoon, characteristic of some of the Micro-lepidoptera.

Under insectary conditions, the adult insect emerges during August. The injured specimen was sent to Mr. W. D. Kearfott, but of course could not be named.

The number of exit holes made by these insect larvæ is enormous in any given area of chestnut forest and as these holes are made just at the time of year that the blight spores are very abundant, and conditions generally are favorable for their development, it is believed that this species of insect has an important bearing upon the spread of *Endothia parasitica*.

A. G. RUGGLES
UNIVERSITY OF MINNESOTA,
November 10, 1913

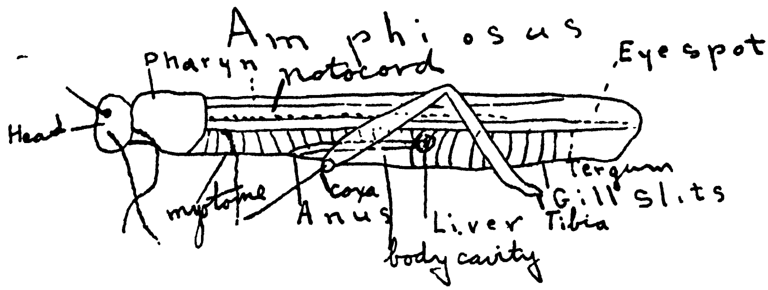
A CONNECTING TYPE?

AN illustration of how completely a student may become confused in a written examination is shown in the accompanying figure, which is an exact tracing, somewhat reduced, of the figure drawn by a freshman in an examination in elementary zoology.

The question was to make a sketch, from memory, of course, of the anatomy of *Amphioxus*, as seen in lateral view.

At first glance the sketch appears to be a fairly good representation of a lateral view of

a grasshopper; but more careful examination will show that there are various parts of *Amphioxus* mixed into the grasshopper in a most remarkable way. These structures are so inconspicuous in themselves that they might have escaped notice if they had not been so plainly indexed, and if the question had been upon the anatomy of the grasshopper instead of the other animal.



That the figure was not drawn as a joke seems evident from the fact that the student failed to pass the examination, and would not, of course, take the chance of having one question thrown out completely. Perhaps the joke is on the instructor, after all.

A. M. Reese

SCIENTIFIC BOOKS

The Early Naturalists: Their Lives and Work (1530–1789). By L. C. Miall, D.Sc., F.R.S. London, Macmillan & Co. 1912.

This book, by a practical naturalist of honorable attainment in the field of research, is a useful book of reference. It has the merit of being written from a thorough examination of the original sources and is a work of great industry and patience. It covers the period from 1530 to 1789 during which the sciences of organic nature were in the process of making. Many of the contributions of the time were mixed, and, taken together, they are more in the nature of vague foreshadowings of what was to come rather than specific additions to any science that had already taken definite form. This circumstance makes it most difficult to convey to the general reader a unified picture of progress, and it is to be said that the book is not dominated by the conception that, notwithstanding details, there is a clear path of advancement in biological thought.

The preface, and his estimate of some of the more prominent men, indicate that the author had this conception in mind, but it is not clearly carried out. The observations of capital importance are not separated from those of subordinate interest, nor are the chief results of investigation sufficiently emphasized to exalt them above those of secondary significance.

In its method the book is analytical rather than synthetic, and does not exhibit the selective and combining power that is necessary to convert the details into a lucid story of progress. Dr. Miall gives, with thoroughness and accuracy, summaries of the researches of the naturalists of the period and of their views on a variety of questions. His volume is a compendious reference rather than an illuminating treatment of tendencies and currents of thought, and seems, to the reviewer, to be of greater service to the naturalist than to the general reader.

His section on "The Minute Anatomists" is the most interesting and the best assimilated part of the book. Here, the author writes with an evident command of the subject, as might be presumed from his familiarity with insect anatomy, as well as his excellent account of Malpighi, Swammerdam and other devotees of minute anatomy, in Miall and Denny's "The Cockroach."

The title "The New Biology" for the first section of the book is suggestive and inviting, but it does not appear to be a happily chosen

title for the period covered—from 1530 to about 1603. The reader is likely to dissent from the inference that the work of Brunfels, Fuchs, Gesner and others constitutes the "new biology" which was more properly the product of the nineteenth century. Nevertheless, his account of the naturalists of this period is very interesting. In the works of Brunfels and Fuchs we find recognition of the practical utility of *affinities* for the systematic arrangement of plants, as well as sketches from nature published before the appearance of the "Fabrica" of Vesalius. This is notable, for there was little objective treatment of science at this time, and few sketches from nature before those prepared under Vesalius, the drawings of Leonardo da Vinci on anatomy being the most notable exceptions.

There are some omissions not readily accounted for. For illustration, one misses reference to the work and the great influence of Vesalius, Harvey, Spallanzani, and the Hunters. These men lived in the period under consideration and, judged in the light of their influence on the developing science of biology, they were founders in as large a sense as any others mentioned. The work of Vesalius served to open the field of morphological studies, and that of Harvey to introduce experimental observation into biological science. While Vesalius might possibly be ruled out, on the ground that his observations were not broadly morphological but applied chiefly to the human body, this is not the case of Harvey, who was not only physiologist but comparative anatomist and observer in embryology as well. Harvey is incidentally mentioned in connection with the embryological work of Malpighi, but his influence was great enough to make him worthy of separate treatment. Spallanzani and John Hunter were naturalists in a broad sense and deserving of representation. Probably Haller should also have some mention.

There are in the book many evidences of ripe scholarship and extensive learning, with an unusually limited number of mistakes. In the section on "Early Studies in Comparative Anatomy" it is probably an error to designate the Essay on Comparative Anatomy of Alexander Munro primus as the earliest formal treatment on the subject. The "Zootomia Democritæ" of Severinus, published a century earlier (1645), is a more likely competitor for this distinction.

It is to be regretted that there are no illustrations in the volume. Portraits of the more notable observers and illustrations selected from their numerous plates would have added greatly to the interest of the book.

The reviewer has read the volume with interest, and while venturing to point out some of its limitations, he is at the same time sensible of its merits.

Wm. A. Locy

The Chemistry of Plant and Animal Life. By Harry Snyder, B.S. Third Revised Edition. New York, The Macmillan Company. Pp. xxii + 388. Price $1.50.

The scope of this little volume is in some respects even wider, in others considerably narrower, than its title would lead one to expect. Of the two parts into which it is divided the first, comprising about two fifths of the text, constitutes a brief introductory course in general chemistry, presenting in elementary fashion the fundamental concepts and laws of the science, and reviewing those elements and simple compounds that from an agricultural standpoint are the most important. The second deals with certain selected phases of biochemical science, such as the characteristic organic compounds of plants and animals, the chemistry of plant growth, the composition of cereals and coarse fodders, the chemistry of digestion and nutrition, and the rational feeding of animals and men. Nearly every chapter contains, besides its expository paragraphs, a number of appropriate problems and laboratory exercises. The whole "is the outgrowth of instruction in chemistry given in the school of agriculture of the University of Minnesota."

The book is, of course, hardly more than a primer, and from a primer much that is interesting and even important must be rigidly excluded. On the other hand, the process of elimination may be pushed too far; and the

reviewer may be permitted to doubt whether the most elementary treatment of the chemistry of life can, for instance, afford to neglect such substances as the amino-acids, or to omit from its vocabulary the word "metabolism." The fact that amino-acids appear sometimes to be vaguely referred to among the "amides" does not diminish the seriousness of the first defect; nor is the second excused by the author's peculiar use of the word "digestion." Digestion, it would seem, is employed to signify not merely the preparation of food for its absorption, but also its subsequent fate within the organism. When this has been grasped it is possible to understand such remarkable statements as that "in order that digestion may proceed in a normal way, a liberal supply of air is necessary to oxidize the nutrients," or that when carbohydrates are "completely digested, carbon dioxide and water are the final products," or that "during . . . digestion, heat is produced in proportion to the calories contained in the food . . . digested."

In discussing the "Nitrogenous Compounds of Plants" the author retains the term "proteid," now generally abandoned by English-speaking chemists. He classifies casein as an "albuminate," vitellin as a "globulin-like body," nuclein and mucin as "albuminoids." The system of protein nomenclature adopted by the American Society of Biological Chemists and the American Physiological Society receives, indeed, no recognition whatever. The doctrine of ferments and fermentation is another theme that might with advantage have been cast in a more modern form. The concept of a ferment does not to-day include such things as the "tubercular organism," and the once important distinction between "organized" and "soluble" ferments has now little more than a historical interest. It is to be regretted that a "revised edition" should perpetuate terminologies and methods of presentation that, to say the least, are obsolescent.

If the weight of these criticisms be allowed to depend to some extent upon the individual point of view, it is otherwise with the actual misstatements that are occasionally encountered. Some of these, to be sure, are mere slips, as when nitrogen is said to constitute "23 per cent." of the atmosphere; others argue chiefly a lack of precision, as when carbon is said to be "present in plant and animal bodies in larger amounts than any other element." But there are several positive blunders. Wax is stated to contain "an ethyl radical in place of the glycerol radical" of fat. The globulin of wheat is called "edestin." Meat is described as containing 0.07 to 0.32 per cent. of an "amide," which bears the name of "keratin." It is obvious enough what substance is being spoken of; but the name is not apparently a simple misprint, for it is thrice employed in one paragraph, and is to be found unaltered in the index.

In spite of the blemishes noted, the book, as a whole, is capable of filling a useful place, and there are many sections which deserve ungrudging commendation. This is especially true of the chapters dealing with the various important food crops, and with their application to the scientific feeding of animals and men. Here the author, speaking often as a first-hand authority, makes a discriminating selection of essential facts, and presents them in a manner at once accurate, lucid and interesting. Many tables of useful data are incorporated, and excellent diagrams illustrate graphically the comparative composition of important foods.

The reviewer can not approve the construction of a sentence like the following: "Iron . . . readily undergoes oxidation and rusting, due to the joint action of oxygen and water, and results in the production of a basic oxid of iron." Fortunately such lapses are infrequent, and the style of the book is in the main straightforward and readable.

ANDREW HUNTER
CORNELL UNIVERSITY

Household Bacteriology. By ESTELLE D. BUCHANAN, M.S., Recently Assistant Professor of Botany, Iowa State College, and ROBERT EARLE BUCHANAN, Ph.D., Professor of Bacteriology, Iowa State College and Bacteriologist of the Iowa Agricultural

Experiment Station. The Macmillan Company. Cloth, 8vo. xv + 536 pp., index. $2.25 net.

During the last decade, the science of household bacteriology has made very wonderful progress as an independent study and as a result we feel to-day a very clear and constant demand for suitable text-books and manuals for use in this new but important field of bacteriology.

The book as presented by the Buchanans consists of a neatly bound volume of 536 pages clearly but simply written. The text is profusely illustrated by original drawings and photographs which add greatly to the attractiveness and usefulness of the book.

"The volume has been divided somewhat arbitrarily into five sections," by the authors. The first three chapters are of an introductory nature and cover the general topic of bacteriological technique. In Section II. more emphasis ought to have been laid on standard methods for the preparation of culture media and more space should have been allotted to the discussion of the cultural characteristics of the yeasts and molds.

Section IV. is given over to fermentation or zymotechnique, as it is called by the authors, and is the best chapter of the book. This section consists of 114 pages and covers the subject of enzymes and their fermentative activities and is characterized by its clear descriptions and explanations of this most complex but interesting subject. The book closes with a section entitled "Microorganisms and Health," consisting of a general discussion of the theory of disease followed by a detailed description of the pathogenic bacteria yeasts and molds. The chapters of this section dealing with the examination of air, water and food might have been elaborated upon and formed into a new section. The volume is supplemented by an appendix containing a key (37 pages) to the families and genera of the common molds which is fully illustrated and must be very useful as a ready means of identifying the common molds of the laboratory.

The main criticism of this volume lies in the title "Household Bacteriology." It is inadequate for two reasons. The book in its present form is too broad to be called a bacteriology and should have been called a microbiology or by some other suitable title. The authors have realized this narrowness of title by using the term microorganism in the heading of every section. Then again this volume is merely a general bacteriology whose title has been extended to cover the field of household bacteriology. With the exception of the poor choice of title, the volume is well written and well adapted for courses in general bacteriology.

William W. Browne
The College of the City of New York

Elements of Water Bacteriology. By Professor S. C. Prescott and Professor C. E. A. Winslow.

Prescott and Winslow's "Water Bacteriology" is the best known book on the subject in America, and it may also be added that it is the best book. This third edition has been entirely rewritten and very much enlarged. The authors state that the revision has been made necessary by the newer ideas on the effect of temperature upon the viability of bacteria in water, the new methods of isolation of specific pathogenic organisms, and the recent recommendations of the Committee on Standard Methods of Water Analysis of the American Public Health Association. The authors do not approve of the recent recommendation of this committee to replace the 20 deg. gelatine count by the 37 deg. agar count. This recommendation has received unfavorable comment at the hands of many American bacteriologists, and has resulted in producing an unfortunate condition of confusion. The authors hold that both the 20 deg. gelatine count and the 37 deg. agar count should be used, and this idea was approved by the Laboratory Section of the American Public Health Association in 1912.

The authors also take issue with the Standard Methods Committee on the subject of the test for *B. coli.* The discussion is too long to be referred to in this review, but it is one of great interest and importance to every bacteriologist and sanitary engineer, and should be

carefully studied. In general, it may be said that the authors hold that fermentation of lactose broth, or lactose bile, may be regarded as a sufficient working test for organisms of intestinal origin. If this idea is carried out it will greatly simplify the routine procedure in the examination of water. The work of the English bacteriologists is discussed at length, particularly that of Houston in London and Clemesha in India.

A new chapter has been added to the book on the bacteriological examination of shell-fish, and it includes the recommendation of the Committee on Standard Methods for the Bacteriological Examination of Shell-fish of the American Public Health Association. The appendix describes the preparation of culture media, and contains an excellent list of references.

GEORGE C. WHIPPLE

SPECIAL ARTICLES

THE CHESTNUT BARK DISEASE ON CHESTNUT FRUITS[1]

SINCE the chestnut bark disease has been so widely studied by the many investigators who have given attention to it within the last few years, numerous articles have been published calling attention to the various ways by which the infection is known definitely to be spread from place to place, as well as of some methods that have been assumed to contribute to its spread. The most prominent of those thus far mentioned have been due to the transportation of spores through the agencies of wind, rain, insects, birds, rodents, man, etc., or to the transportation of various fruiting and vegetative parts, or fragments of the fungus, by means of infected cordwood, poles, ties, bark, grafting scions, nursery stock, etc. So far as the writer knows, no one has called special attention to the danger of the disease being transmitted by means of infected chestnut fruits, yet infected nuts at times undoubtedly are capable of spreading the disease, as will be realized from what follows, which describes one case which has come to our notice.

[1] Published by permission of the Secretary of Agriculture.

In September, 1912, Professor R. Kent Beattie, Dr. T. C. Merrill and the writer found numerous nuts and burs, which had been lying on the ground in Lancaster county, Pennsylvania, for several months, upon which were many reddish brown pustules, in a buff or yellowish mycelium. These looked very much like the pycnidial pustules and mycelium of *Endothia parasitica*. Portions of the diseased fruits were inoculated by the writer into the bark of a grafted Paragon chestnut tree, while for comparison some inoculations were made at the same time from a typical canker. The infected nuts were collected on September 4, 1912, and the infected bark was collected and the inoculations made on the following day. The records and results of these inoculations are given below.

The limb selected for inoculation was healthy-looking, apparently free from disease, from one to two inches in diameter, but on a tree that was already diseased on some other limbs. Eighteen cuts through the bark were made with a sterile knife-blade, except as noted below in the case of two cuts. For convenience in referring to these cuts they have been numbered consecutively from 1 to 18. Nos. 1, 2, 5, 6, 7, 8, 11, 12, 13, 14, 17 and 18 were checks, all uninoculated in the ordinary sense, though cuts 13 and 14 were made with the knife-blade after it had been used to cut some of the infected bark to be inserted in cuts 15 and 16.

Cuts 3 and 4 were inoculated with pieces of the mycelium-covered shell of the nut after the pustules had been cut away; cuts 9 and 10 were inoculated with pieces of the shell to which pustules were still attached; and cuts 15 and 16 were inoculated with pieces of bark from a disease lesion on the bark of an American chestnut tree.

On July 22, 1913 (about ten and one half months after the inoculations were made), the inoculations and checks were reexamined and records made of their condition. Cuts 1 and 2 were uninfected. Cut 3 likewise was uninfected. Cut 4 had developed a characteristic lesion about 4 inches long. Cut 5 was sur-

rounded by disease, apparently from two confluent lesions, one of which started about midway between cuts 4 and 5, but on the opposite side of the limb, while the other started near cut 5 and on the same side of the limb. Judging only from the size of these lesions, they must have originated soon after the inoculations were made. There was no evidence that any infection had started at cut 5. Cut 6 was uninfected. Cuts 7 and 8 showed sunken areas but no fans, pustules, nor other symptoms of the disease. Cut 9 had developed a girdling lesion 7 inches long with very many pustules. Cut 10 had developed a lesion 4½ inches long and 3 inches wide. Cuts 11, 12, 13 and 14 were uninfected. Cuts 15 and 16 had produced confluent girdling lesions aggregating 11 inches in length. This probably indicated that each cut had produced a lesion about 6 inches in length, as the cuts were about 5 inches apart. Cuts 17 and 18 were uninfected.

The results of these inoculations may briefly be summarized as follows:

2 inoculations from typical canker on bark, both successful.
2 inoculations from pustules on nut, both successful.
2 inoculations from mycelium on nut, one successful.
10 checks cut with sterile knife, none infected.
2 checks cut with contaminated knife, none infected.

These inoculations indicate that the disease was present on or in the nuts and burs collected. Although the latter were not used in the inoculations, the nuts and burs were covered with the same fungus, judging only from an examination with a hand lens; and, moreover, the nuts and burs were in contact when collected.

Perhaps nuts infected in this manner are not likely often to reach the market, and presumably would be unsalable either for seed purposes or for eating if they did reach it. In the latter case an additional source of danger would be created by discarding the diseased nuts, perhaps in a new locality far distant from the place where they were grown. In any event, the possibility of the disease at times being disseminated through great distances in this manner can not be overlooked in summing up the evidence bearing on this phase of investigation.

J. Franklin Collins
Office of Investigation in Forest Pathology, Bureau of Plant Industry, Providence, R. I.,
October 20, 1913

INTERGLACIAL MOLLUSKS FROM SOUTH DAKOTA

Mr. W. H. Over, of the University of South Dakota Museum, recently submitted for study a most interesting collection of interglacial mollusks. The material, consisting of wood, cones, shells, etc., in muck, were found in a well 20 feet below the surface, two or three miles north of Grandview, in Douglas County, South Dakota.

Professor James E. Todd thus refers to this material:[1]

> *An Ancient Tamarack Swamp.*—Near Grandview, in the southeast quarter of sec. 33, T. 100, R. 64, were found traces of more recent occupation of the region by trees. In a well which had been dug on the edge of a basin near a branch of Andes Creek at the depth of 20 feet was found a layer of muck several inches in thickness, in which were pieces of wood with numerous fresh-water shells of nearly a dozen species. But the most remarkable thing was the stem of a hemlock or tamarack about 10 inches in diameter lying across the well, and in the muck were numerous cones evidently of the same species. Overlying this trace of a tamarack swamp was mud of various colors and consistency, evidently washed from the surrounding hillsides. That it should be so deeply buried was chiefly explained by its connection with the channel of Andes Creek. This was conclusive evidence that the region had been occupied more or less by timber since the ice had covered the region, possibly while the second moraine was in process of formation. Similar finds are reported from wells several miles west of that place.

The overlying till here is Wisconsin, which varies greatly in thickness. The surface is yellow clay underlain by blue clay. The

[1] Bull. 158, U. S. Geol. Survey, p. 121, 1899.

former is Wisconsin while the latter is apparently Kansan. Professor Todd evidently correlates the deposit with the later Wisconsin when he says:

This was conclusive evidence that the region had been occupied more or less by timber since the ice had covered the regions, possibly while the second moraine was in process of formation.

The late work of the Iowa geologists, Calvin, Shimek and others, indicates that the underlying blue clay was laid down by the Kansan ice sheet, and hence the fossil remains must be regarded as post-Kansan and pre-Wisconsin.

From this new angle of view the fossils become of great interest. The mollusks were submitted by Professor Todd to Professor R. Ellsworth Call, who recognized the following species.[2]

Limnophysa palustris Say.
Limnophysa decidiosa Say.
Gyraulus parvus Say.
Valvata sincera Say.
Segmentina armigera Say.

But five species are here recorded, although Professor Todd refers to "nearly a dozen species."

In the material submitted by Mr. Over, which is a part of the original lot, fifteen species are recognized, as noted below:

Pisidium compressum Prime.
Pisidium variabile Prime.
Pisidium medianum Sterki.
Valvata tricarinata Say.
Valvata lewisii Currier.
Succinea avara Say.
Physa sp. (immature).
Galba palustris Müll.
Lymnæa stagnalis appressa Say.
Planorbis trivolvis Say.
Planorbis bicarinatus Say.
Planorbis bicarinatus striatus Baker.
Planorbis deflectus Say.
Planorbis parvus Say.
Planorbis exacuous Say.

Two species, *Segmentina armigera* and *Limnophysa* (*Galba*) *decidiosa*, mentioned by Call, were not detected in the material recently examined. Thirteen species are likewise included which were not mentioned by Call, possibly because the material did not contain them. *Valvata sincera* as identified by Call also proves to be *Valvata lewisii.*

[2] *Op. cit.*, p. 121, footnote. The old momenclature is used.

The fauna is thus seen to have been large and varied. The deposit was evidently the bed of a large lake or river, and could not have been a tamarack swamp as stated by Professor Todd, because mollusks such as *Valvata tricarinata* and *V. lewisii* do not inhabit such a station. The tamarack log and cones mentioned probably floated from the shore and became buried in the mud. That this fauna lived in or near the present Andes Creek is not at all possible, because such an assemblage of life would scarcely be found in this kind of a habitat.

With just which interglacial stage this biota is to be correlated is not yet clear. If it immediately preceded the Wisconsin, which seems probable, it may be Peorian (post-Iowan); or if it became extinct before this stage it may be the equivalent of the Sangamon (post-Illinoian); if it is to be classed as post-Kansan, as it lies upon the Kansan till, it must be correlated with the Yarmouth stage. In the absence of equivalent loess deposits it is difficult, if not impossible, to place this deposit in its true position in the paleontologic column. A restudy of the Grandview deposits from the modern, multiple glacial standpoint would assist greatly, doubtless, in solving this problem.

My thanks are due to Dr. Bryant Walker and Dr. Victor Sterki for kind assistance in the determination of doubtful material.

FRANK C. BAKER
THE CHICAGO ACADEMY OF SCIENCES

THE INDIANA ACADEMY OF SCIENCES

THE Indiana Academy of Sciences and the Indiana Conservation Association met in joint session in Indianapolis, October 24–25. Some of the important papers were as follows:

President Donaldson Bodine's address on "How to Increase the Efficiency of the Academy."

"The Flood of March, 1913."

At Terre Haute, Charles R. Dryer.

At Fort Wayne, L. C. Ward.

On the Ohio River in Southeastern Indiana, Glen Culbertson.

On East and West Forks of White River, H. P. Bybee.

"The Selective Action of Gentian Violet in the Bacteriological Analysis," C. M. Hilliard.

"The Vertical Distribution of Plankton in Winona Lake," Glenwood Henry.

"A Test of Indiana Varieties of Wheat Seed for Internal Fungous Infection," George N. Hoffer.

"A Simple Apparatus for the Study of Phototropic Responses in Seedlings," George N. Hoffer.

"Mosses of Monroe County, Indiana, II.," Mildred Nothnagel.

"Observations on the Aquatic Plant Life in White River Following the Spring Flood of 1913," Paul Weatherwax.

"The Occurrence of *Aphanomyces phycophytes* upon the Campus of Indiana University," Paul Weatherwax.

"Food and Feeding Habits of *Unio*," William Ray Allen.

"Oral Respiration in *Amphiuma* and *Cryptobranchus*," H. L. Bruner.

"Respiration and Smell in Amphibians," H. L. Bruner.

"General Outline of Trip of 1913 for the Purpose of Collecting the Fish Fauna of Colombia, S. A.," Charles E. Wilson.

"A Topographic Map of the Terre Haute Area," Charles R. Dryer.

"Center of Area and Center of Population of Indiana," W. A. Cogshall.

"On the Shrinkage of Photographic Paper," R. R. Ramsey.

"A Preliminary Account of an Elaborate Study of the Disintegration of Matter," A. L. Foley.

"Boiling and Condensing Points of Alcohol-water Mixtures," P. N. Evans.

"Race Suicide," Robert Hessler.

"A Psychologist's Investigation in the Field of Crime among Adolescents," R. B. von KleinSmid.

"Agricultural Work in Southern Indiana," C. G. Phillips.

"The Germination of *Arisæma dracontinus*." Lantern. F. L. Pickett.

"The Prothallium of *Camptosorus rhizophyllus*." Lantern. F. L. Pickett.

"Irish Potato Scab as Affected by Fertilizers Containing Sulphates and Chlorides." Lantern. S. D. Conner.

"Newly Discovered Phenomena Connected with the Electric Discharge in Air." Lantern. A. L. Foley.

"The Relation of the Country Life Movement to Conservation," Mrs. Virginia C. Meredith.

"The Conservation of Indiana Soils and Crops," Mr. D. F. Maish.

"The Present Status of Agricultural Education in Indiana," Professor George I. Christie.

"A Sanitary Survey of Indiana Rivers," Dr. Jay Craven.

"The Relation of the Lakes of Northern Indiana to Problems of Flood Control," Dr. Will Scott.

"Municipal Forestry in Indiana," Hon. Charles Warren Fairbanks.

"First Steps in Indiana Forestry," Professor Stanley Coulter.

"Taxation of Forest Lands," Professor H. W. Anderson.

"Forests and Floods," Professor F. M. Andrews.

"Prevention of Infant Mortality as a Factor in Conservation," Dr. J. N. Hurty.

"The Analysis of an Occupation," Professor M. E. Haggerty.

"School Hygiene as a Factor in the Conservation of Human Life," Dr. O. B. Nesbit.

"County Tuberculosis Hospitals as a Factor in the Conservation of Human Life," Dr. James Y. Welborn.

"Playgrounds and Recreation Centers as Factors in the Conservation of Human Life," Dr. W. A. Gekler.

"Public Toilet Facilities, Drinking Fountains and Public Spitting in Relation to the Conservation of Human Life," Professor C. M. Hilliard.

"Possible Dangers from Drilling for Oil and Gas in Coal Measures," Professor Edward Barrett.

"Power Economy and the Utilization of Waste in the Quarry Industry," Mr. G. C. Mance.

A. J. BIGNEY,
Secretary

THE CONVOCATION WEEK MEETING OF SCIENTIFIC SOCIETIES

THE American Association for the Advancement of Science and the national scientific societies named below will meet at Atlanta, Ga., during convocation week, beginning on December 29, 1913.

American Association for the Advancement of Science.—President, Professor Edmund B. Wilson,

Columbia University; retiring president, Professor Edward C. Pickering, Harvard College Observatory; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.; general secretary, Professor Harry W. Springsteen, Western Reserve University, Cleveland, Ohio; secretary of the council, Professor William A. Worsham, Jr., State College of Agriculture, Athens, Ga.

Section A—Mathematics and Astronomy.—Vice-president, Dr. Frank Schlesinger, Allegheny Observatory; secretary, Professor Forest R. Moulton, University of Chicago, Chicago, Ill.

Section B—Physics.—Vice-president, Professor Alfred D. Cole, Ohio State University; secretary, Dr. W. J. Humphreys, Mount Weather, Va.

Section C—Chemistry.—Vice-president, Dr. Carl L. Alsberg, Bureau of Chemistry; secretary, Dr. John Johnston, Geophysical Laboratory, Washington, D. C.

Section D—Mechanical Science and Engineering.—Vice-president, Dr. O. P. Hood, U. S. Bureau of Mines; secretary, Professor Arthur H. Blanchard, Columbia University, New York City.

Section E—Geology and Geography.—Vice-president, J. S. Diller, U. S. Geological Survey; secretary, Professor George F. Kay, University of Iowa.

Section F—Zoology.—Vice-president, Dr. Alfred G. Mayer, Carnegie Institution of Washington; secretary, Professor Herbert V. Neal, Tufts College, Mass.

Section G—Botany.—Vice-president, Professor Henry C. Cowles, University of Chicago; secretary, Professor W. J. V. Osterhout, Harvard University, Cambridge, Mass.

Section H—Anthropology and Psychology.—Vice-president, Professor Walter B. Pillsbury, University of Michigan; acting secretary, Dr. E. K. Strong, Jr., Columbia University, New York City.

Section I—Social and Economic Science.—Vice-president, Judson G. Wall, Tax Commissioner, New York City; secretary, Seymour C. Loomis, 69 Church St., New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor Theodore Hough, University of Virginia; secretary, Dr. Donald R. Hooker, Johns Hopkins Medical School, Baltimore, Md.

Section L—Education.—Vice-president, Dr. Philander P. Claxton, Commission of Education, Washington, D. C.; secretary, Dr. Stuart A. Courtis, Liggett School, Detroit, Mich.

The Astronomical and Astrophysical Society of America.—December 29–January 3. President, Professor E. C. Pickering, Harvard College Observatory; secretary, Professor Philip Fox, Dearborn Observatory, Evanston, Ill.

The American Physical Society.—December 29–January 3. President, Professor B. O. Peirce, Harvard University; secretary, Professor A. D. Cole, Ohio State University, Columbus, Ohio.

The American Federation of Teachers of the Mathematical and the Natural Sciences.—Between December 30. President, Professor C. R. Mann, University of Chicago; secretary, Dr. Wm. A. Hedrick, Washington, D. C.

The Entomological Society of America.—December 30–31. President, Dr. C. J. S. Bethune, Ontario Agricultural College; secretary, Professor Alexander D. MacGillivray, 603 West Michigan Ave., Urbana, Ill.

The American Association of Economic Entomologists.—December 31–January 2. President, Professor P. J. Parrott, Geneva, N. Y.; secretary, A. F. Burgess, Melrose Highlands, Mass.

The Botanical Society of America.—December 30–January 2. President, Professor D. H. Campbell, Stanford University; secretary, Dr. George T. Moore, Botanical Garden, St. Louis, Mo.

The American Phytopathological Society.—December 30–January 2. President, F. C. Stewart, Agricultural Experiment Station, Geneva, N. Y.; secretary, Dr. C. L. Shear, Department of Agriculture, Washington, D. C.

The American Microscopical Society.—December 30. Secretary, T. W. Galloway, James Millikin University, Decatur, Ill.

American Association of Official Horticultural Inspectors.—December 29. President, E. L. Worsham, Atlanta, Ga.; secretary, J. G. Saunders, Madison, Wis.

The Southern Society for Philosophy and Psychology.—December 31–January 1. President, Professor H. J. Pearce, Gainesville, Ga.; secretary, Professor W. C. Ruediger, George Washington University, Washington, D. C.

The Sigma Xi Convention.—December 30. President, Professor J. McKeen Cattell, Columbia University; recording secretary, Professor Dayton C.

Miller, Case School of Applied Science, Cleveland, Ohio.

Gamma Alpha Graduate Scientific Fraternity.—December 30. President, Professor J. I. Tracey, Yale University; secretary, Professor H. E. Howe, Randolph-Macon College, Ashland, Va.

PHILADELPHIA

The American Society of Naturalists.—December 31. President, Professor Ross G. Harrison, Yale University; secretary, Dr. Bradley M. Davis, University of Pennsylvania, Philadelphia, Pa.

The American Society of Zoologists.—December 30–January 1. *Eastern Branch:* President, Dr. A. G. Mayer, Tortugas, Fla.; secretary, Professor J. H. Gerould, Dartmouth College. *Central Branch* December 29–January 1: president, Professor H. B. Ward, University of Nebraska; secretary, Professor W. C. Curtis, University of Missouri, Columbia, Mo.

The American Physiological Society.—December 29–31. President, Dr. S. J. Meltzer, Rockefeller Institute for Medical Research, New York City; secretary, Professor A. J. Carlson, University of Chicago, Chicago, Ill.

The Association of American Anatomists.—December 29–31. President, Professor Ross G. Harrison, Yale University; secretary, Professor G. Carl Huber, 1330 Hill Street, Ann Arbor, Mich.

The American Society of Biological Chemists.—December 29–31. President, Professor A. B. Macallum, University of Toronto; secretary, Professor Philip A. Shaffer, 1806 Locust St., St. Louis, Mo.

The Society for Pharmacology and Experimental Therapeutics.—December 30–31. President, Dr. Torald Sollmann, Western Reserve University Medical School, Cleveland, Ohio; secretary, Dr. John Auer, Rockefeller Institute for Medical Research, New York City.

NEW YORK CITY

The American Mathematical Society.—December 30–31. President, Professor E. B. Van Vleck, University of Wisconsin; secretary, Professor F. N. Cole, 501 West 116th Street, New York City. Chicago, December 26, 27, secretary of Chicago meeting, Professor H. E. Slaught, University of Chicago, Chicago, Ill.

The American Anthropological Association.—December 29–31. President, Professor Roland B. Dixon, Harvard University; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-Lore Society.—December 31. President, John A. Lomax, University of Texas; secretary, Dr. Charles Peabody, 197 Brattle St., Cambridge, Mass.

PRINCETON

The Geological Society of America.—December 30–January 1. President, Professor Eugene A. Smith, University of Alabama; secretary, Dr. Edmund Otis Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—Probably meets at Princeton but official information has not been received.

The Paleontological Society.—December 31–January 1. President, Dr. Charles D. Walcott, Smithsonian Institution; secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

NEW HAVEN

The American Psychological Association.—December 30–January 1. President, Professor Howard C. Warren, Princeton University; secretary, W. Van Dyke Bingham, Dartmouth College, Hanover, N. H.

The American Philosophical Association.—December 29–31. President, Professor E. B. McGilvary, University of Wisconsin; secretary, Professor E. G. Spaulding, Princeton, N. J.

MINNEAPOLIS

The American Economic Association.—December 27–30. President, Professor David Kinley, University of Illinois; secretary, Professor T. N. Carver, Harvard University, Cambridge, Mass.

The American Sociological Society.—December 27–30. President, Professor Albion W. Small, University of Chicago; secretary, Scott E. W. Bedford, University of Chicago, Chicago, Ill.

WASHINGTON, D. C.

The American Association for Labor Legislation.— December 30–31. President, Professor W. W. Willoughby, Princeton University; secretary, Dr. John B. Andrews, 131 East 23d St., New York City.

MONTREAL

The Society of American Bacteriologists.—December 31–January 2. President, Professor C. E. A. Winslow, College of the City of New York; secretary, Dr. A. Parker Hitchens, Glenolden, Pa.

SCIENCE

FRIDAY, DECEMBER 19, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ON THE NATURE OF MATHEMATICAL AND SCIENTIFIC DEMONSTRATION[1]

IN the development of every science there is a growth of method as well as of results. We are accustomed to give close attention to the latter, and frequently we reorganize them into connected and logical wholes so that every student may conveniently view them in their entirety and in their proper relations to one another. In determining the method by which the matter shall thus be organized we are generally guided by considerations of convenience in exposition.

In much of our teaching, likewise, the selection and arrangement of material is determined primarily by a desire to arrive at results in the most expeditious manner possible.

One effect of this controlling emphasis, both in lecturing and in the writing of books, is that many of us never come to a proper appreciation of the labor which has been expended in perfecting our tools of investigation and never have a vital conception of the character of the important problem of method. Such a person usually will be able to employ only the tools which are presented to him by others. He will not be able to devise a new method to meet the needs of the new problem which arises in his own work.

Now the most important steps forward are made by the introduction of new methods of advancement. It is obvious that the person most likely to discover the

[1] An address delivered on the evening of October 6, 1913, to "The Euclidean Circle," an organization among the graduate and undergraduate students of mathematics in Indiana University.

new method is the one who understands best the fundamental ideas on which the methods of his subject are based and the relation of these ideas and methods to corresponding ones in allied fields of study.

It is, therefore, important to the student of every science to analyze the growth of method in his science and to ascertain the fundamental basis on which it has developed. This analysis requires a wider grasp of the subject than the student can possess in the early years of his labor. But he can appreciate, to a large extent, the results of such an analysis and profit by a knowledge of them, if they are presented by some one of a fuller experience than himself.

It is my purpose this evening to present to you the outcome of such an analysis of the nature of mathematical and of scientific demonstration.

A method which was considered useful and legitimate in one generation has often been discarded in the next. Sometimes it has been replaced by another which was merely more powerful and at least equally convenient. At other times it has been found to be not a legitimate method; and it has been necessary to abandon it because investigators could no longer be sure of results obtained by means of it. This has been true both of mathematics and of experimental science, but less frequently of the former than of the latter.

For a mathematical method a first requisite is that the mind shall assert with the strongest emphasis that the method is legitimate. We shall say nothing about how this conviction may have arisen: we shall first demand of it only that it shall be a profound and universal conviction of the human mind.

I shall illustrate what I mean here by an example. Let us take the principle or method of mathematical induction. It is convenient to consider a particular case of its use. Suppose that we wish to demonstrate the binomial theorem,

$$(a+b)^n = a^n + na^{n-1}b + \cdots + nab^{n-1} + b^n,$$

for every positive integer exponent n. Our method of procedure is as follows: We first observe that the theorem is true for n equal to 1. The next step is to prove that if it is true for n equal to k, where k is any positive integer, it is likewise true for n equal to $k+1$; and we shall suppose now that this step has been made by the necessary argumentation. Now we know that the theorem is true for n equal to 1; from the result last mentioned we conclude further that the theorem is true for n equal to 2. Since it is true for n equal to 2 we may apply our previous result again and conclude that is is true for n equal to 3. Likewise we proceed to the case when n is equal to 4; and so on.

Now, if one analyzes the principle on which this argument is based, the conclusion comes home to him with a compelling force; and he can not fail to have confidence in it. He has verified the theorem perhaps in only a few cases; but he has no fear that a case will ever be found to contradict it.

The first requirement of a mathematical method, as I have said, is that it shall possess just this property of compelling confidence in the conclusions reached by its means. The ground of this compelling power in the method the mathematician (as such) does not seek to find; that is a problem for the philosophers.

But such credentials as those mentioned, however good they may appear to be, are never accepted by the mathematician as entirely satisfactory. He does not, indeed, dispute their legitimacy. But, through much experience, he has found that methods exist concerning which the uninitiated

mind asserts emphatically that they are valid, whereas he knows cases in which they lead to inconsistent results.

Therefore these credentials are treated by the mathematician as affording him only a means of making a first choice of methods to be examined. They are still to be subjected to tests in the laboratory of the mind.

You may ask: To what sort of test may one conceivably subject a method which the mind approves with as much confidence as it does that of mathematical induction, for instance? There seems to be just one such test available. Does it always lead to consistent results? I do not say true results; for there is no one to determine whether the results are true. If several methods are involved at once, it is to be demanded of them also that the results obtained by means of any of them shall be consistent with those obtained from others.

Effectively, what the mathematician does, then, is to select a number of methods in the intuitional way which I have indicated and then to subject them to the most exacting requirements in the way of consistency of results obtained by their use—results exact in their nature and deduced from exact data and covering a wide range of thought.

The only methods which he retains after these extended tests are those which have never been known to lead to a contradiction at any time in the history of human thought. One other analysis must finally be made before they can be admitted into the privileged circle of mathematical methods. It must be ascertained of a given method whether it is perfectly precise in its nature in the sense that no two persons of intelligence have a different opinion as to what the method is. There is no disagreement, for instance, among thinkers concerning the definition of mathematical induction.

Once the mathematician has selected some methods which he is willing to employ, he uses them in argument in the coldest and most formal way. In making discoveries intuition plays a most important rôle and is a precious guide which he can not dispense with. But when he states his proofs he does it in terms which are entirely free from intuition. Further, he is careful to make sure that he has used no methods except those which have already successfully passed his most searching scrutiny. Through sore experience he has learned that safety lies in no other direction.

But this is not all. Every new use of his methods gives rise to the possibility at least that a contradiction has crept in through some argument which has never before led into such error; and this possibility must be examined—certainly in all cases where the research opens up a new field of thought, if not also in the more common investigations.

It is due to this extreme carefulness on the part of the mathematician that we have so strong a feeling of certainty in his conclusions. But if we analyze this feeling with care we shall find, unexpectedly perhaps to most of us, that it is due after all to our experience with the methods employed, since under the most severe tests they have never led us into contradiction. (They are the only methods which possess this latter property.)

If you will recall what I said about the way in which the mathematician has selected his tools of investigation, you will see why he can never be absolutely sure that he has employed a proper procedure in argument. At no stage in the development of his method was there an absolute criterion according to which a method was to be

retained. He proceeded entirely by exclusion. First, all conceivable methods which did not come up to a certain standard were put aside. Those that remained were subjected to further tests, one after another, and some of them were found to be unsatisfactory. Those left over were finally retained because they had the negative recommendation of never having been caught in an act of deception.

What shall we say then of the certainty of mathematical doctrine at the present day? To answer this question, let us observe that, in all preceding generations, methods in mathematics have been used with confidence which, in the experience of a later day, were found to be not legitimate; they have been discarded, sometimes after generations of confident use. It is not likely that men have heretofore always made mistakes of this kind and that we have suddenly come upon an age in which mathematical methods are certain in the absolute sense.

We are then forced to the conclusion, however unwelcome it may be, that the certainty of mathematics is after all not absolute, but is relative. To be sure, it is the most profound certainty which the mind has been able to achieve in any of its processes; but it is not absolute. The mathematician starts from exact data; he reasons by methods which have never been known to lead to error; and his conclusions are necessary in the sense, and only in the sense, that no one now living can point to a flaw in the processes by which he has derived them.

When we find ourselves forced to this result, our first feeling is probably one of disappointment. But a deeper analysis of the matter will bring us to a different attitude. It gives us a new sense of the problem which lies before us in the development of mathematical thought. We have not merely to seek new results; but we have also the larger problem of method to inspire our activity and to lead us perhaps to fundamental achievement.

It is conceivable that methods may be devised by means of which we shall attain to well-nigh perfect certainty. Let us suppose that we have found a method of argument, or a principle A, which has this property, namely: In whatever way we start from a principle not in accord with it we shall be led into results which are themselves mutually contradictory. Now suppose that principle A is itself not a legitimate one. Then there is a legitimate principle B not in accord with it. From this new principle we can get mutually contradictory results. That is, principle B is both legitimate and not legitimate. This being a contradiction in itself, we conclude that the hypothesis from which it is deduced is false. Therefore principle A is legitimate. I say that it is conceivable that such principles A will some day be discovered; but they have not yet been found.

In an earlier day, and of course without the aid of such principles as I have just mentioned, men apparently had come to a feeling of absolute certainty about the accuracy of mathematical conclusions. Those fundamental methods of argumentation, of which I spoke in the outset, they conceived to belong to a class of innate or inherent ideas which had been put in the mind of man by the Creator. The initial hypotheses and basic notions of a mathematical discipline they thought of as belonging to the same category. If these innate ideas did not have all the elements of absolute certainty, there could be only one conclusion: the Creator had deliberately deceived man. Since they considered this to be absolutely impossible, they had complete confidence in the certainty of mathematical results.

This is merely one example of the usual dependence of the ancients on the authority of abstract reason. By this means they sought absolute certainty in scientific as well as in mathematical and philosophical thought. A brief account of their general point of view in regard to this matter will serve to connect the two topics which I have asked you to associate together this evening; for it is in the ancient time that the two methods are most closely related.

It is convenient to speak of the position of Plato. This philosopher refers, with a touch of contempt, to one who gives his life to the investigation of nature, feeling that such a person was concerned with the visible universe alone and was immersed in its phenomena. These, whether past or present or to come, admit of no stability and therefore of no certainty. "These things," he says, "have no absolute first principle and can never be the objects of reason and pure science." Plato believed that the senses are deceptive and could never lead to the discovery of truth. The only way to develop science was to look within and find there the fundamental principles on which it should be based; and then to develop logically the consequences of these principles.

But I shall not take up your time with an analysis of these old opinions, however much they may have influenced or retarded science in times past. Neither shall I pause to indicate how the old Greek science, such as it was, came into a place of authority, dominating the thought of many generations and giving rise to a fearful intellectual stagnation. I prefer to come to the time when the development of scientific method began to recover men from their stupor and to kindle a new intellectual light and fervor.

Let me direct your attention to the Italian philosopher Bernardino Telesio (1509–1588) as the great figure who marks the period of transition from authority and reason to experiment and individual responsibility. He was the forerunner of all subsequent empiricism, scientific and philosophical, sowing the seeds from which sprang the scientific methods of Campanello and Bruno, of Francis Bacon and Descartes and the scientists of our day. He abandoned completely the purely intellectual sphere of the ancient Greeks and other thinkers prior to his time and proposed an inquiry into the data given by the senses. He held that from these data all true knowledge really comes.

The work of Telesio, therefore, marks the fundamental revolution in scientific thought by which we pass over from the ancient to the modern methods. He was successful in showing that from Aristotle the appeal lay to nature; and he made possible the day when men would no longer treat the *ipse dixit* of the Stagirite philosopher as the final authority in matters of science.

It is true that Telesio had been preceded almost three centuries by Roger Bacon (1214?–1294?), a modern thinker in the middle ages, whose conceptions of science were more just and clear than those at a date four centuries after his birth. But this Bacon was a man born out of time, too far in advance of his age to be appreciated by it; and consequently he had but little influence on the growth of scientific method. The balance has now been restored in his favor, so far as the judgment of historians is concerned; but that leaves untouched the facts of effective scientific progress.

Telesio had several followers, or perhaps we should say fellow pioneers, in the same field. Among these Francis Bacon probably stands out as the most prominent of all. He said of himself that he "rang the bell which called the wits together." But his contributions to the stock of actual scien-

tific knowledge were practically inconsiderable. His great merit lay in his making men see that science was in fundamental need of a new method. The method he suggested was not adopted; but his analysis of the need was the signal for the search which has ended in modern science.

I need not take you further through the long history. It is sufficient to my purpose to point out that primitive man first developed by experience a way of his own for observing and fixing in mind external phenomena, that the Greeks seized upon their own and their predecessors' observations and sublimed experience into theory, that Telesio and Bacon and others taught mankind the insufficiency of Greek methods and the need of new ones, and that modern science came into being and fulness of stature through generations of workers who sought to put, and succeeded in putting, the new ideas into the form of effective tools of advancement.

From this brief historical account it is seen that the method of experimental science has itself grown through experiment. The style of argument employed by Plato, for instance, has been entirely superseded by another and better. Man had to learn by the experience of failure how to ascertain the true relations of phenomena. In other words, there was no "preestablished harmony" between the mind and the phenomena it had to interpret of such character as to lead the former to a ready explanation of the latter.

Our progres in this respect has been over a hard and long and rough road. We go a very short distance, relatively, into our past to find the time when methods were uniformly employed in science which are now known to be quite untrustworthy. What is the bearing of this fact on our confidence in the conclusions of science? In order to answer this question properly we shall have to analyze briefly the general nature of scientific investigation as at present practised.

In the first place, scientific demonstration starts from data which involve the ever-present inexactness which is due to experimental error. In the nature of things it is impossible that the argumentation should ever have an exact basis to rest upon; and consequently all conclusions must again be tested by a direct appeal to phenomena. In another important respect also the method is essentially different from that employed in mathematics. Here intuition is a fundamental guide in argument as well as in discovery; and a "proof" whose leading elements are grounded in intuition is accepted with a confidence at least equal to that which is accorded to one characterized by mathematical precision and rigor.

One result of this inexact basis and especially of this loose method of argumentation is that the conclusions reached often are primarily of the nature of inference from examples. They have little or none of the compelling property which attaches to mathematical conclusions.

In other words, scientific (as opposed to mathematical) truth is not necessary truth. It is in the nature of things that the experimental scientist can not give us absolute truth. This is no criticism of his work; it is not his province to give us absolute truth —even if such a thing were supposed to exist.

What then is the purpose of the experimental scientist? His province is to enable us to get around among the phenomena of the external world, to predict what will happen under a given set of circumstances. He will accomplish this end by studying the relations among phenomena. He does not need to know their ultimate explanation; it is sufficient if he can find the essen-

ful threads of interconnection among them. Therefore he does not seek absolute certainty in his theories, at least when he realizes the fundamental limitations of his methods; but he understands his theories rather as the most convenient means by which he may summarize for himself and others the actually observed interrelations in nature.

Now, let us suppose that an experimental scientist attempts to attain absolute certainty in his conclusions, and enquire as to the kind of difficulty which he will encounter.

An analysis of the matter shows, first of all, that he must make one fundamental assumption—that involved in the hypothesis of the uniformity of nature. If phenomena have no laws it is futile to ascribe laws to them; and therefore a first requisite for the existence of experimental science is the supposition that laws exist. It must be assumed that the universe will not suddenly depart to-morrow from its previous way of behaving; it must not be a thing of caprice

But what ground have I for believing that to-morrow will not put forth a set of phenomena totally different from those which I have observed before? None at all, except what comes through my belief in the uniformity of nature. It is clear that this is not the way by which the principle is to be established. In fact, we can go further and say with confidence that there is no absolute certainty, but only a high degree of probability, that nature is uniform.

There is also another fundamental assumption at the basis of experimental science—one that is curiously related to the mind that has made the assumption.

A fundamental property of mind is memory; without it mind can not exist in its usual state. What one does to-day is colored, modified, perhaps determined by one's memory of past acts. No experiment on a thinking subject can be performed for the second time; for the presence of memory in the second event is a factor of determining importance and can not be left out of account.

And yet mind, of which this is a characteristic and fundamental property, has chosen to assume that matter is without memory. If I desire to experiment with a falling stone, I need not enquire whether the stone has gone through the same experience before. In other words, I assume that the stone has no memory of its previous existence; and consequently its previous history will not affect my present experiment.

If it is true that experimental science is so shot through with basic assumptions, what is to be said of our confidence in its results? What measure of certainty attaches to them and how do we come to that certainty? Clearly, the evidence must be indirect; but it need not on that account be less trustworthy.

We may arrive at one phase of this evidence by noticing what change has taken place in man's relation to natural phenomena since the dawn of the modern era in scientific investigation. It is patent to every one that there has been an immense gain in control; man has harnessed the forces of the world and is using them for his purpose. A thousand and one new instruments of power and pleasure attest to his more profound understanding of the relations among phenomena. For hundreds of miles he can transfer the immense power of Niagara along a slender wire, and then use it to run his machinery and light his cities and warm his houses. In every conceivable direction he is making progress decade by decade; and the momentum of his progress increases as the years pass.

But even this is not the chief reason for believing that he is essentially right in his

interpretation of the relations of phenomena. His strongest ground of confidence is in the multiplicity and the accuracy of his predictions—predictions which he verifies by further tests in the laboratory.

Probably the severest test of a physical theory is the requirement that it predict accurately a phenomenon which has not yet been observed; and this is a test to which theory is constantly subjected—and it comes out successful. This is the ground of our confidence in physical theories. It is this which lends the strongest possible credence to such a general hypothesis, for instance, as that of the uniformity of nature.

This ultimate test of prediction finds its most extensive exemplification in the results obtained by the apparatus of abstract mathematical ideas. From a few fundamental laws, as for instance those of static electricity, an immense body of doctrine is built up by the processes of mathematical analysis. The results so obtained are exact and are stated with careful precision. Notwithstanding their great variety and the absolute precision with which they are stated, they are found to be always in accord with new experiment however the conditions may be varied. It is this which furnishes our strongest ground of confidence in physical theory; it is not the argumentation or inference by which the theory was first discovered or created.

The success of this prediction through mathematical or other argumentation is so great that we can not escape the conclusion that science is on the right track; improvements will come, to be sure, but we have certainly made some fundamental progress. In fact, the ground for this conclusion is so strong that the burden of proof must rest on whoever disputes its validity. If our theories are essentially erroneous, it requires careful explanation to understand why our attempt to put them in mathematical language has issued in such a remarkable success in the way of relating and predicting phenomena.

Even though we are still left face to face with the conclusion that there is no absolute certainty in our scientific theories, we see nevertheless that our ground of confidence in them is such as to justify our laying out our life and its activity as if they were so. We shall accept them as our guide in getting around among external phenomena. And we can do this even with more confidence than we can plan those things which depend on our own acts. Indeed there is much greater certainty attaching to the prediction of physical phenomena than to the prediction of our own acts; and what more could one reasonably demand of science?

Now of the two methods which we have considered, the mathematical and the experimental-scientific, which is the better? You will probably expect me to say that the mathematical method is the better; but I do not say it. Neither is the better; the question is meaningless. Each method is of profound importance and each is suited to its proper purposes; each will be improved as time passes and will be carried over more and more into all fields of thought and conduct; and each will continue to add new conquests to human achievement. But we shall not say that one is better than the other.

Most of you to whom I have spoken this evening are at the threshold of life. The future lies before you. You will doubtless choose some definite work to do in it. Would you like to have a part in promoting those fundamental ends of human development which may be secured through the use of one or the other of these great methods of advancement?

But what is it to have a part in using

and perfecting these tools, the two chief means by which mankind is making progress in our day? What sort of work is it? It is hard; it is no child's play; it is the work of maturity and strong purpose. The material rewards are few; probably not many of your generation will appreciate your labors, and most of you perhaps will not be heard of after your day. But you will leave mankind a heritage of profit forever, you will hasten the day when all men will know that their chief benefactors are those who delve into the secrets of nature and reveal them to their fellows. Does that work appeal to you?

R. D. Carmichael

RECOLLECTIONS OF DR. ALFRED RUSSEL WALLACE

It is impossible for any man to discuss adequately the life work of Alfred Russel Wallace. His activities covered such a long period, and were so varied, that no one living is in a position to critically appreciate more than a part of them. We are very much interested, of course, and have our opinions; but we need not pretend to any final or complete judgment. All must agree that a great and significant career has just been closed, but its full measure will probably never be known to any single man.

On the other hand, it may be possible to gain a clear idea of the character and aims of Dr. Wallace; and for our purposes this is perhaps the more important thing, since his guiding principles may also become ours, while the work he did is his alone. I once asked him about the origin of his interest in biology, and in the course of his reply[1] he said: "As to my interest in biology, . . . I doubt if I had or have any *special* aptitude for it, but I have a natural love for *classification* and an inherent desire to *explain things;* also a great love of beauty of form and color." Again, in writing to the biology students of the University of Colorado, he said:[2]

> The wonders of nature have been the delight and solace of my life. . . . From the day when I first saw a bee-orchis in ignorant astonishment . . . nature has afforded me an ever-increasing rapture, and the attempt to solve some of her myriad problems an ever-growing sense of mystery and awe.

This is the spirit of the amateur, using that word in its best and true sense. When Wallace had been long in the Malay Archipelago, a relative wrote urging him to return, and in his reply he gave the reasons why he could not do so, and said:

> So far from being angry at being called an enthusiast (as you seem to suppose), it is my pride and glory to be worthy to be so called. Who ever did anything good or great who was not an enthusiast?

This was his attitude to the end of his life, and only those who have some measure of the same feeling can understand it. The worldly wisdom of a professional threading his way through the maze of opportunity to one of the prizes of life was wholly foreign to his nature; he was, instead, the "irresponsible enthusiast," keenly anxious to see and know, *loving* nature and man, always wishing to communicate to others some of the pleasure and knowledge he had gained. To some his frequent advocacy of unpopular causes suggested perfect indifference to public opinion, and a total disregard of ordinary prudence. Whether, in this or that matter, we believe him to have been right or wrong, we must admire a man who always had the courage of his convictions; and so far from being indifferent to the feelings and opinions of others, his sympathetic nature and longing for fellowship *caused* him to so zealously expound what he believed would be helpful to other men.

I had of course revelled in "The Malay Archipelago" when a boy, but my first personal relations with Dr. Wallace arose from a letter I wrote him after reading his "Darwinism," then (early in 1890) recently published. The book delighted me, but I found a number of little matters to criticize and discuss, and with the impetuosity of youth, proceeded to write to the author, and also send a letter on some of the points to *Nature*. I have

1 *Popular Science Monthly*, April, 1903, p. 517.

2 Science, March 29, 1912, p. 487.

possibly not yet reached years of discretion, but in the perspective of time I can see with confusion that what I regarded as worthy zeal might well have been characterized by others as confounded impudence. In the face of this, the tolerance and kindness of Dr. Wallace's reply is wholly characteristic:

I am very much obliged to you for your letter containing so many valuable emendations and suggestions on my "Darwinism." They will be very useful to me in preparing another edition. Living in the country with but few books, I have often been unable to obtain the *latest* information, but for the purpose of the argument, the facts of a few years back are often as good as those of to-day—which in their turn will be modified a few years hence. You refer to there being five species of *Aquilegia* in Colorado. But have they not each their station, two seldom occurring together? During a week's botanizing in July in Colorado I only saw two species, *caerulea* and *brevistyla*,—each in their own area. Though the Andrenidae are not usually gaily colored, yet they are not *inconspicuous*. The Chrysididae are, I should think, colored so brilliantly, partly, perhaps, to simulate stinging species, and partly to prevent their being taken for fruits or seeds when rolled up. They are *very* hard, and like many hard beetles, are colored as a *warning of inedibility*. In the Rocky Mountains I think there is a *real scarcity* of Monocotyledons, especially bulbous Liliaceae and Amaryllids, and Orchises. This struck me as being the case. You appear to have so much knowledge of details in so many branches of natural history, and also to have thought so much on many of the more recondite problems, that I shall be much pleased to receive any further remarks or corrections on any other portions of my book.[8]

This letter, written to a very young and quite unknown man in the wilds of Colorado, who had merely communicated a list of more or less trifling criticisms, can only be explained as an instance of Dr. Wallace's eagerness to help and encourage beginners. It did not occur to him to question the propriety of the criticisms, he did not write as a superior to an inferior; he only saw what seemed to him a spark of biological enthusiasm, which should by all means be kindled into flame. Many years later, when I was at his house, he produced with the greatest delight some letters from a young man who had gone to South America and was getting his first glimpses of the tropical forest. What discoveries he might make! What joy he must have on seeing the things described in the letters, such things as Dr. Wallace himself had seen in Brazil so long ago!

[8] Letter, February 10, 1890.

It is comparatively easy for many of us to teach, as we do in schools. No doubt we communicate the "essentials" of our subjects in a fairly competent manner; but would that we had in this country more grand old men with the will and right to bless the succeeding generations as they come.

Some letters of August and September, 1890, refer to a suggestion of mine that a collection of all the recorded facts bearing on evolution should be made.

The proposal you make of a collection of all the recorded facts bearing upon the various problems of *Darwinism* is a very good one. Such a body of facts would be most valuable to naturalists, but I question whether it would pay for its publication. I feel sure my publishers would not agree to "weight" my book with such a mass of additional matter. The only thing, therefore, would be to publish the materials separately, as Darwin did in his "Animals and Plants under Domestication." I hope *you* will do this yourself, as you have evidently a taste for this kind of work. . . . It would, however, be a tremendous task, as it would involve wading through the *whole* literature of natural history for the last twenty years.

In a second letter:

If half a dozen workers could be found to undertake the work of collection I should think the Royal Society would give funds for the publication, as the work would be really a *supplement to Darwin's works*, and might be suggested as a *Literary Memorial* to him.

The project was never even on the way to be carried out, owing to various circumstances. I believe it might even now be begun, and that it would be well worth while. For example, we have no good collection of data concerning the relations between specific characters and locality, or on the relative frequency of variation in different species, and a number of other

equally interesting topics. One constantly reads good papers on experimental work, which suffer from the almost total ignorance of the authors concerning the variability and different specific characters of the genera they are dealing with. Not only could much that is valuable be obtained from the literature, but the museums are full of materials which on examination would yield a rich harvest.

Dr. Wallace was greatly impressed with the waste of opportunity in our museums, and not very long ago (Sept. 30, 1909) wrote urging that something should be done.

If you can find time I wish you would write to "Nature"—or if at more length to the "Fortnightly Review"—on a matter of great importance to the philosophical study of biology. Our vast accumulations of plants at Kew, and of insects at the Natural History Museum contain a mass of most valuable geographical and statistical information, quite *lost, useless* and *unknown,* owing to the absurd system of devoting all the time and energies of the staff of curators, etc., to describing new species or small groups here and there, or publishing a few enormous and very costly works like Sharpe's Catalogue of Birds, —which, though intrinsically of great value, are lost to the *mass of workers* owing to *cost* and bulk. Thiselton-Dyar wrote me lately that he "*groans* over the masses of material which lie useless and unknown at Kew." I have urged the last and present Directors of the Natural History Museum to devote their influence to making a simple *Catalogue* of the Museum contents, beginning with the richest and most popular families or sub-orders of insects—Longicorns, Carabidae, Cicindelidae, Lamellicornes, etc., also *Diurnal Lepidoptera.* This catalogue or list, could be made by intelligent *clerks* only, by going over the cabinets or cases, in systematic order, and entering every *specific name* (or sp. nov.) and the *numbers* of the *specimens* in the Museum from *each separate locality.* The clerk or clerks would be under the general supervision of the Curator of the special department. From this manuscript list, a card-catalogue should be set up and stereotyped; there being a card for each species and named variety, and in the case of all wide-spread species, separate cards for each *Continent* or each considerable *Country.* By printing several *sets* of these cards, a card-catalogue for any sub-family or genus, or for any *geographical region* or *country,* could be made up at a *low price,* and would be invaluable to all private collectors, as telling them at once what *is* in the B. M., and *where from,* while the number of *specimens* would be some guide to the abundance or rarity of the species. I am immensely impressed with the value of the plan of *Card Catalogues,* so much used in America, but I suppose almost unknown here except for Libraries. I have no time or strength to go into this subject properly. . . .

Dr. Wallace had not seen some of the more recently published works, in which such information as he desired had actually been given; but it was and is true that all large museums might do much more for the advancement of biological science, were they to fully utilize the materials at their command. The greatest objection to catalogues compiled in the manner suggested is that the determinations of specimens are frequently unreliable, so that expert revision of the several groups would be necessary in the first place. This means more curators, and therefore more expense. It is however a very wasteful policy, which would wreck any private business, to keep up a large museum at enormous cost, and then cut off the funds at the point of providing an adequate staff to take care of the contents. It is as though a large department store were furnished with everything except enough clerks and salesmen to attend to the customers. Several curators of the U. S. National Museum, to whom I put the question, concurred in the opinion that 5 per cent. added to the total cost of running the museum, put into expert curators, would double the scientific output. In addition to taxonomic workers, museums ought also to have men with broad interests like those of Dr. Wallace, whose business it would be to survey and expound the facts relating to geographical distribution, variation, etc., obtainable from the collections. Thus at the British Museum, Hampson's great work on the moths of the world might be made the basis for many interesting generalizations, which would interest and instruct many who could not obtain or read the original severely taxonomic volumes.

In October, 1890, after I had returned to England, Dr. Wallace wrote that he was about

to prepare a new edition of his "Island Life," and asked me to help secure the information necessary to bring it up to date. I of course gladly agreed to do this, and was supplied with the loose sheets of the first edition, which I carried to the British Museum (Natural History) and the library of the Zoological Society, comparing the chapters with recent literature, and especially consulting different naturalists on their specialties. This not only proved extremely interesting work, but it gave me an introduction to many men I had wished to meet, and especially brought me into constant communication with Dr. Wallace himself. All who were approached courteously gave the best aid in their power; but one chapter, that on the British Islands, proved quite a bone of contention. Dr. Wallace had given lists of animals and plants peculiar to those islands, enumerating all the species and varieties which appeared not to have been recorded from elsewhere. He argued that while no doubt these lists required amendment, yet it was probably true that we possessed a considerable series of endemic forms. Almost without exception, the naturalists of that time expressed great scepticism on this point, while some freely ridiculed the whole idea. Even when furnishing data, they hastened to say that they were probably of no value. Since that time, careful collections have been made by British naturalists on the continent, and much work of various kinds has been undertaken which bears directly upon the question of an endemic element in the British fauna. The result has been to reveal an amount of divergence far in excess of Dr. Wallace's expectations; so much so, that when a few years ago I mentioned to him the recent results of mammalogists, he was not himself prepared to go so far, but said they surely must be splitting hairs.

Early in 1891 I went down to Parkstone and had the great pleasure of meeting Dr. and Mrs. Wallace. For about a week I spent a large part of each day at Dr. Wallace's house and sometimes went for walks with him. I now regret that I kept no notes of the conversations, but I recall that we discussed all the debatable biological and sociological questions of the day. More especially, we talked about the inheritance of acquired characters, and tried to postulate crucial experiments to prove the matter one way or the other. We found it extremely difficult to even imagine an experiment which should be above all possible criticism. There was also much to be said about geographical distribution; and just at that time I had published some remarks on alpine plants in *Nature*, which had called forth adverse criticism, to which I replied while at Dr. Wallace's house. I remember that he encouraged me to go forward in this matter, and not mind if people said I was out of my proper department. He believed in, and of course illustrated by his own conduct, the right of any man to study what he chose, and not be limited in his intellectual activities because his colleagues had labelled him this or that.

After my return home we continued to discuss the inheritance of acquired characters through the mails, especially since at that time Dr. Romanes and others had on foot a project for an experimental station. The following is from a letter of February 7, 1891:

> Your former letter (of Feb. 2) giving Romanes' reply to you, set me going and I immediately wrote to Galton. I enclose his reply, which please return when you are writing next. I then sat down and sketched a series of a dozen sets of experiments to test the two questions of "*heredity of acquired characters*" and the "amount of sterility in the hybrids between closely allied species,"—and also a few to test the questions of instinct in nest building, and the "homing" power of dogs, cats, etc. These I am now sending to him and shall then receive his objections to them as affording tests. In the mean time will *you* try and formulate a few experiments which would serve as *crucial tests* of the question of the "heredity of individually acquired characters?" You may hit on some that will meet the objections he will probably make to mine. I do not think there will be any difficulty in getting good observers in paid servants under the supervision of a committee.

On February 13 Dr. Wallace reported the receipt of a long letter from Galton, criticizing some of the suggested experiments. The letter continues:

I suggested some experiments something like yours, and many others. I do not quite agree with you that if acquired characters *are* inherited, they might only be so very rarely. If *inherited* (to be of any use in the theory of evolution, and *that* is the whole question) they ought to be inherited as frequently as *other* characters are inherited, that is, I presume, in about *half* the offspring. If only one in 100 exhibited the character how could you possibly say it was not a normal variation in that individual? *Only* by the very frequent inheritance could you *prove* that there was any inheritance at all! I think you will see this. But it is too elaborate a question to discuss in letters.

On February 18, however, he discussed the matter at greater length:

As you are a student of *variation* I thought you would see my point without explanation. Now I will explain. The following three points I consider to be proved by overwhelming evidence, a summary of which is given in "Darwinism," Chap. III.

1. All increasing or dominant species (and it is from these that new species arise) vary considerably, in all their *parts, organs* and *faculties*, in *every generation*.

2. The amount of this variation is so large that when only 20 to 50 adults are compared it reaches from 10 to 20 per cent. of the mean value of such characters as can be accurately measured.

3. The proportion of individuals which vary considerably is large, reaching to one fourth, or one third of the whole number compared. In other words, the curve of variation is low. . . .

Hence it follows that *whatever character* is increased or diminished in individuals by the effect of the environment, a similar increase or diminution will occur by genetic variation, in each generation, and in certainly 5 or 10 per cent. of the individuals dealt with. Hence your supposition that in the check lots *no* such modification would occur as in those exposed to special conditions is almost an impossible one; and an effect produced on *one* or even on *five* or 10 per cent. by special conditions would be imperceptible, because similar effects would occur through normal variation and often to a much greater amount. Hence I said, that to be *clear* and *decisive* the effect produced by the conditions should be inherited by a *large proportion* of the offspring. You may say that the effects of conditions would be *additional* to the normal effects of variation. True. And if largely inherited they would soon show it, but if as you first supposed only one per cent., that would be entirely swamped by the irregularities of normal variation and inheritance. You must remember too that experiments on a very large scale, and with check experiments on an equally large scale, and all carried on for many years, would require a very large establishment and ample funds not likely to be obtained. Again, the whole *raison d'être* of this enquiry is to decide whether inheritance of acquired characters is of any importance in the origin of species. To be of importance it must rank in generality with variation, otherwise it is entirely superfluous, even if it exists, and variation could do perfectly well without it. Yet again, either there is a fundamental cause of such inheritance or there is not. If there is,—if such inheritance is a *law of nature*, why should it not rank with the inheritance of genetic variations?—which are, I presume, to the extent of about *one half?* If it was only one per cent., it might be a fluke! It would require innumerable experiments to prove it was anything else.

I have given this discussion partly to show that even in those days there was much talk of experimental work, and that the necessity for such work was fully appreciated. Dr. Romanes prepared a statement, which was widely circulated, urging that an experimental station should be established at Oxford or Cambridge,[4] but the funds were not forthcoming. We thought at one time that Oxford would rise to the occasion, but she failed to do so, and it was long after that Cambridge established a chair of genetics.

During the winter I unsuccessfully competed for a position in the Marine Biological Station at Plymouth, and Dr. Wallace kindly interested himself on my behalf. When, in April, I was appointed curator of the museum of the Institute of Jamaica, I had reason to believe that Dr. Wallace had a good deal to do with the matter, since he evidently knew all about it before I told him. He wrote me a charming letter of congratulation:

How you will revel in the land Molluscs, and how you will punish the poor slugs who have hitherto been unregarded by collectors! . . .

[4] "Life and Letters of George John Romanes," second ed. (1896), p. 269.

You will also be able to have a garden, and to be within easy reach of the higher ranges of mountains where hosts of new insects and molluscs remain for *you* to discover! As *you* will treat the poor niggers as "men and brothers," you will have no difficulty in getting any servants you require. . . .

In the following year Dr. Wallace himself thought of visiting Jamaica, and wrote:

Should you see any nice little cot to let in some nice place in the mountains, with plenty of rock and forest near by, let us know, and if we can let our house here for 6 months we *may* possibly come and be renovated by the glorious sun of Jamaica.

In 1893, after I had gone to New Mexico, Dr. Wallace wrote (Sept. 10):

I and wife went to the *Lakes* for a month in July and August,—our first visit there. I was delighted both with the scenery and the glacial phenomena. The mountains are very precipitous, with fine bold outlines and grand precipices, and their summits, at 3,000 feet, quite as grand examples of mountain structure and of denudation as 12,000 or 14,000 feet peaks in the Rockies!

The years passed by, bringing good and ill fortune, and it was not until June, 1904, that I again saw Dr. Wallace. He had moved from Parkstone to Broadstone, where he had built a house in an ideal spot, surrounded by a beautiful garden, and with a small greenhouse annexed. Adjacent to the garden is a sort of miniature forest; "this," he said, "we call the tulgey wood." Every morning he went out early, to see what flowers had opened, and to pick the strawberries. His enthusiasm over the flowers was unbounded; as he himself said, the passage of years had increased instead of dulling his love of natural beauty. We were shown the new hybrid roses, and especially the rockeries, where many beautiful alpines were growing to perfection. One day we all went to Corfe Castle, and Dr. Wallace, in spite of his age, was able to climb the hill on which that ruin stands, and examine every part of it.

In subsequent years my wife and I frequently heard about the garden, sometimes from Dr., sometimes from Mrs. Wallace. They sent us seeds of *Anchusa* and old-fashioned English pinks, which have done very well in our garden at Boulder; we sent *Rosa stellata* and the new red sunflower, both of which were first grown in England by the Wallaces. On June 26, 1911, soon after the publication of "The World of Life," Dr. Wallace wrote:

After the hard labor of my book, and the flood of correspondence about it, chiefly from admirers,—I am taking relaxation in a new *rock and bog garden*, which I have been making, and especially in growing as many as I can of the lovely genus *Primula*, especially the fine new species recently discovered in the mountains of *China* and the *Himalayas*. These I am growing as much as possible from seed, as their beauty is only shown in groups or masses; and I have already got altogether about 40 species (chiefly presents from Kew, Edinburgh, Dublin, etc.). I am very anxious to get *your* very remarkable and fine *Primula Rusbyi* from New Mexico, and in the hope that your university may have a botanical garden, or that some of your botanists may grow it; I shall greatly prize some *seed* gathered and posted in a letter as soon as the capsules are mature. Seed of the Californian *P. suffruticosa* and the Coloradan *P. Parryi* will also be very welcome, as well as of any other American species, if such there are.

P. rusbyi I had never obtained at any time; the allusion to my species was probably due to some recollection of the equally fine *R. ellisiae*, which it was impossible to procure. We did, however, obtain some roots of *P. parryi*, and Dr. Wallace wrote:

I have received a very nice little parcel of *fine roots* of the handsome *Primula Parryi*, which I saw growing luxuriantly near Kelso's cabin, below Gray's Peak, at 11,500 feet, and which I hope to see in flower again next spring, as I have given it a place where it can get its *roots in water*, as it did there, on the margin of the stream.[6]

In the same letter he says:

About two months back was much surprised and pleased to have a visit from Miss Eastwood, my companion in our trip to *Gray's Peak* and *Grizzly Gulch*, in July, 1887, where we saw the American Alpine flora at the snow-line in perfection.

Then again:

Answering letters, reading the papers, mags. and books, with a lot of *novels* fills up my time,

[6] Litt., December 17, 1911.

with attention to my Alpines and seedling Primulas, though I have promised to write an important article, when I feel up to it, "*On the Influence of the Environment on Morals.*" We are having the dullest, dampest and dreariest winter I remember, after the hottest summer! . . . The political and foreign situation is now most interesting with us, and I am glad to have lived to see such a hopeful dawn.

The last time I saw Dr. Wallace was immediately after the Darwin Celebration at Cambridge in 1909. I was the first to give him the details concerning it, and vividly remember how interested he was, and how heartily he laughed over some of the funny incidents, which may not as yet be told in print. One of Dr. Wallace's most prominent characteristics was his keen sense of humor, and his enjoyment of a good story. At the banquet at Cambridge those present united in sending him a telegram expressing their sense of his great part in the event they were celebrating, and their regret that he could not be present. This was not delivered until the next morning, and Dr. Wallace was concerned lest it should have been thought that he delayed in sending a reply. I was able to assure him that we knew at the time that it was too late for delivery that day.

As recently as February 3, 1913, Mrs. Wallace wrote:

Dr. Wallace is very well and busy, writing as hard as ever; he has just passed 90, and feels like 50.

Much later in the year (July 1) we heard from my brother that he was "splendidly well," and not many months after, the sad news appeared in the daily papers. In one of his letters he said that except for the infirmities natural to old age he felt quite as keen as he had ever done in his youth, and thought this a good sign for the persistence of personality after death. This keenness never waned to the end, and who shall say that this eager spirit has not still some place in the realm of being?

T. D. A. Cockerell

SCIENTIFIC NOTES AND NEWS

The Nobel prizes in the sciences have been awarded to Professor H. K. Onnes, of the University of Leiden, in physics; to Professor Alfred Werner, of the University of Zurich, in chemistry, and to Professor Charles Richet, of the University of Paris, in medicine.

At the anniversary meeting of the Royal Society Sir William Crookes was elected president to succeed Sir Archibald Geikie. Other officers were elected and prizes were conferred as already announced in Science. At the annual dinner the principal toast, "The Royal Society," was proposed by Mr. Page, the American ambassador. The retiring president announced a gift of £5,000 for physical research from Sir James Caird.

Dr. J. H. Comstock, for thirty-nine years instructor and professor of entomology at Cornell University, will retire from the active duties of his chair at the close of the present academic year.

Dr. Herman M. Biggs has retired as chief medical officer of the Department of Health of the City of New York, having rendered distinguished service to the city in that office.

Professor Cleveland Abbe, the distinguished meteorologist of the U. S. Weather Bureau, celebrated his seventy-fifth birthday on December 4.

The gold medal of the Apothecaries Society, London, has been awarded to Mr. J. E. Harting, in recognition of his services in preparing and editing the catalogue of the library in Apothecaries' Hall.

The portrait of Professor Horace Lamb, F.R.S., was presented on November 27 by subscribers to the University of Manchester, where he has filled the chair of mathematics since 1885, and is now senior professor. The portrait of Professor Lamb was painted by his son, Mr. Henry Lamb. The presentation was made by Professor Tout and Professor Rutherford.

Dr. Charles S. Minot has been elected an honorary member of the Anatomical Society of Great Britain and Ireland.

At a special meeting of the Royal Spanish Society of Natural Science held in Madrid on November 28, Dr. W. J. Holland, the director of the Carnegie Museum in Pittsburgh, was elected an honorary member to fill the vacancy in the list of honorary members created by the death of Lord Avebury. At the same meeting Mr. Arthur S. Coggeshall, of Pittsburgh, was elected a corresponding member of the society.

Professor R. W. Wood, of the Johns Hopkins University, who is spending the year abroad, is engaged in research work in the laboratories of the Sorbonne and the Ecole Normal Superieur (Paris) in collaboration with Hemsalech, Dunoyer and Ribaud. His address is 14 Ave. Charles Floquet, Paris.

At the annual meeting of the Entomological Society of Washington, held on December 4, 1913, the following officers were elected: *President,* W. D. Hunter; *First Vice-president,* A. N. Caudell; *Second Vice-president,* E. R. Sasscer; *Editor,* W. D. Hunter; *Corresponding Secretary-Treasurer,* S. A. Rohwer (U. S. National Museum, Washington, D. C.); *Additional Members of the Executive Commitee,* Dr. L. O. Howard and Messrs. E. A. Schwarz and August Busck. These officers will be installed at the first meeting in January.

Mr. N. Cunliffe, B.A., Trinity College, has been appointed assistant to the superintendent of the Museum of Zoology of Cambridge University.

Dr. Sebastian Albrecht has been appointed astronomer at the Dudley Observatory, Albany.

E. J. McCaustland, professor of municipal and highway engineering at the University of Washington, Seattle, has been appointed by the county commissioners as consulting engineer for King County. In conjunction with the state highway commissioner Mr. McCaustland will act as adviser to the county engineer in the expenditure of three million dollars for permanent highways.

At the regular fall meeting of the Chicago chapter of the Sigma Xi held on December first, the society was addressed by Professor Jacques Loeb, of the Rockefeller Institute for Medical Research, who spoke on "Recent Experiments in Artificial Parthenogenesis."

During the week of December 1-6, Professor Lafayette B. Mendel, of the Sheffield Scientific School of Yale University, gave addresses on "Viewpoints in the Study of Growth" and "Food Fads" before chapters of the Sigma Xi society at the University of Kansas, University of Missouri and Washington University in St. Louis.

Professor Douglas W. Johnson delivered the following series of illustrated lectures on "The Interpretation of American Scenery" before the Institute of Arts and Sciences of Columbia University on Saturday evenings during the month of November: The Scenery of American Rivers; Shoreline Scenery of the Atlantic Coast; The Sculpture of Mountains by Glaciers, and the Scenery of the Grand Cañon District.

On the evening of November 14, Professor W. W. Atwood, of Harvard University, presented an illustrated lecture to the Geographic Society of Chicago on "The Ascent of Uncompagre and a Trip through the San Juan Mountains of Colorado."

Professor Arthur H. Blanchard, of Columbia University, on December 6, delivered an illustrated lecture on "Modern Developments in Highway Engineering," before the Drexel Institute of Philadelphia.

Dr. Wolfgang Ostwald, Privatdozent at the University of Leipzig, editor of the *Kolloid-Zeitschrift* and the *Kolloidchemische Beihefte,* and known for his many scientific contributions to biology and chemistry, has been invited by the Cincinnati branch of the American Chemical Society and the Cincinnati Research Society to give a series of five lectures on colloid-chemistry in the University of Cincinnati during the week of January 5 to 10. The lectures embrace a discussion of the general properties of colloids with scientific and technical applications. In the week of January 12 to 17 these lectures will be repeated at the University of Illinois; January 19 to 24

at Columbia, January 26 to 31 at Johns Hopkins; February 2 to 7 at the University of Chicago.

THE Huxley lecture at Birmingham University for this year is to be delivered by Sir Arthur Evans, F.R.S., who has chosen as his subject "The Ages of Minos."

THE Swiney lectures on geology in connection with the British Museum (Natural History) are being given this year by Dr. T. J. Jehu, his subject being "The Natural History of Minerals and Ores."

PROFESSOR ALFRED G. COMPTON, former head of the physics department at the College of the City of New York, who retired in December, 1911, after serving on the faculty of the college for fifty-eight years, died on December 12, aged seventy-eight years.

DR. JAMES MACALISTER, for twenty-two years president of the Drexel Institute at Philadelphia, and previously superintendent of public schools, died on December 11, at the age of seventy-three years.

PROFESSOR DR. ANTON FRIČ, one of the most distinguished of the paleontologists of Europe, died in Prague on the fifteenth of November, in the eighty-first year of his age. Professor Frič's greatest contributions were to the Permian fauna of Bohemia, especially the Amphibia and fishes, and also the insects. He has also left a permanent record in his direction of the beautiful natural history museum at Prague which is in many respects the most perfect of its kind in Europe. He was a man of very great energy and a voluminous writer. His published works include many large volumes which will become classics in paleontological literature.

PROFESSOR IGINO COCCHI, of Florence, known for his work in stratigraphical geology, the first president of the committee directing the Geological Survey of Italy, has died at the age of seventy-five years.

THE foundation-stone was laid on November 23 at Frankfurt-on-Maine of the new zoological institute of the Senckenberg Natural History Museum which the Senckenberg Society will ultimately place at the disposal of the future University of Frankfurt.

THE thirty-first German Congress of Internal Medicine will be held at Wiesbaden, April 20–23, under the presidency of Professor von Romberg, of Munich. The chief subject proposed for discussion is the nature and treatment of insomnia. The reporters are Drs. Gaupp, of Tübingen; Goldscheider, of Berlin, and Faust, of Würzburg.

THE committee charged with the local arrangements for the recent visit to Birmingham of the British Association has held its final meeting. It was reported that the number of persons taking tickets for the meeting was 2,635, compared with 2,504 at the Dundee meeting last year and 2,453 at the Birmingham meeting in 1886. The extent to which the artisan classes availed themselves of the popular science lectures made them a notable feature of the meeting. The Finance Committee recommended that an unexpended balance of £2,313 be returned to the contributors proportionately.

A PRIZE of one hundred dollars is offered for the best paper on "The Availability of Pearson's Formulæ for Psychophysics." The rules for the solution of this problem have been formulated in general terms by William Brown. It is now required (1) to make their formulation specific, and (2) to show how they work out in actual practise. Papers in competition for this prize will be received not later than December 31, 1914, by Professor E. B. Titchener, Cornell Heights, Ithaca, N. Y. Such papers are to be marked only with a motto, and are to be accompanied by a sealed envelope, marked with the same motto, and containing the name and address of the writer. The prize will be awarded by a committee consisting of Professors William Brown, E. B. Titchener and F. M. Urban. The committee will make known the name of the successful competitor on July 1, 1915.

PARTICULARS of the Pierre J. and Edouard Van Beneden prize of 2,800 francs are quoted in *Nature*. The prize is to be awarded every three years to the Belgian or foreign author

or authors of the best original work of embryology or cytology written or published during the three years preceding the date on which competing theses must be received. For the first competition this date is December 31, 1915. The manuscript works may be signed or anonymous, and the French, German, or English language may be employed. Authors should send their contributions to the permanent secretary of the academy, Palais des Académies, Brussels, inscribed "Concours pour le Prix Pierre-J. et Edouard Van Beneden."

President Wilson, in his annual address to members of Congress, referred to the United States Bureau of Mines in the following manner: "Our Bureau of Mines ought to be equipped and empowered to render even more effectual service than it renders now in improving the conditions of mine labor and making the mines more economically productive as well as more safe. This is an all-important part of the work of conservation; and the conservation of human life and energy lies even nearer to our interest than the preservation from waste of our material resources."

The British home secretary has appointed a committee to inquire what action has been taken under the Wild Birds Protection Acts for the protection of wild birds and to consider whether any amendments of the law or improvements in its administration are required. The members of the committee are: The Hon. E. S. Montagu, M.P., under-secretary of state for India (chairman); Lord Lucas, parliamentary secretary to the board of agriculture; Mr. Frank Elliott, of the home office; Mr. E. G. B. Meade-Waldo, Mr. W. R. Ogilive Grant and Mr. Hugh S. Gladstone. The secretary to the committee is Mr. H. R. Scott, of the home office.

The annual inspection trip of the department of electrical engineering of the University of Illinois took place November 23–26. The trip was under the charge of Professors E. B. Paine, Morgan Brooks, E. H. Waldo and J. M. Bryant. The party was divided into two sections. One section visited the Keokuk water power plant, while the other visited the industries around Joliet, Illinois. The sections met in Chicago, where the trip was concluded. Features of the trip were the inspection of the parts of the Commonwealth Edison system in Chicago, the Hawthorne works of the Western Electric Company and the Illinois Steel Works.

UNIVERSITY AND EDUCATIONAL NEWS

Announcement is made at Yale University that the new biological laboratories are to be called the "Osborn Memorial Laboratories." The funds, amounting to half a million dollars, were provided for in the will of the late Mrs. Miriam A. Osborn. The laboratories accommodate the departments of zoology, comparative anatomy and botany.

Regulations for admission to the military academy at West Point have been modified so that without lowering the entrance requirements prospective cadets may be matriculated by substituting equivalents for some of the units of study hitherto insisted upon. Hereafter a candidate for admission may be excused from mental examination upon presentation of certificate that he is a regularly enrolled student in good standing in a university, college or technological school, the entrance requirements of which include proficiency in mathematics and English as outlined by the college entrance examination board, or a certificate that he has graduated from a preparatory school meeting the requirements of that board, or a certificate that he has passed fourteen units of the entrance examinations required by the board requiring mathematics, English and history.

Recommendation has been made to the Argentine Congress to send to America for two years' study at government expense two professors from each faculty of each national university.

Mrs. Ella Flagg Young has resigned as superintendent of Schools of the City of Chicago because certain members of the board voted against her re-election. It is now said

that these members of the board have resigned and that Mrs. Young may accept the election.

DR. LIVINGSTON FARRAND, professor of anthropology in Columbia University, has been elected president of the University of Colorado.

PRESIDENT THOMAS F. KANE, of the University of Washington, was removed from office on December 12 by the board of regents, who unanimously adopted a resolution declaring the office vacant. The action was the climax of an agitation that has lasted three years, in which a majority of the faculty and students are said to have aligned themselves against President Kane.

AMONG new appointments at the University of Montana are: N. J. Lennes, Ph.D. (Chicago), instructor in Columbia University for the past three years, to be head of the department of mathematics, and A. George Heilman, M.D. (Pennsylvania), to be instructor in biology and physiology.

DR. W. T. GORDON has been appointed lecturer and head of the geological department at King's College, London, in succession to Dr. T. F. Sibly, appointed professor of geology at the University of South Wales, Cardiff.

DR. G. OWEN, lecturer in physics at Liverpool University, has been appointed professor of physics at Auckland University College, New Zealand.

DISCUSSION AND CORRESPONDENCE

MORE PALEOLITHIC ART

BY degrees paleolithic stations are being rediscovered. The large rock shelter of La Colombière, valley of the Ain, some thirty miles southwest of Geneva, is an example. Known since 1875 it had been only superficially explored. The important discoveries of Dr. Lucien Mayet, of the University of Lyons, and M. Jean Pissot, of Poncin, date from October, 1913; and were first announced through the Paris Academy of Sciences on October 20. The trench they dug revealed in section: (1) neolithic at the top; (2) a Magdalenian horizon, the upper section of which with the neolithic had been disturbed by earlier investigators; (3) a layer of fine sand with débris from the overhanging rock, one meter thick, in which no relics were found, representing a long period of non-habitation by man; (4) Aurignacian layer with fossil remains of the mammoth, woolly rhinoceros, reindeer and horse. Here also was a workshop left by Aurignacian man, flint tools and rare engravings characteristic of the epoch.

The principal find is a large fragment of mammoth bone on which are engraved human figures; a head and upper part of the body including an out-stretched arm and hand; likewise a figure with head and feet missing, probably a female. Both these engravings are in profile, the view easiest to master by a primitive artist working in outline. Fairly good examples of the human form in the round and in relief dating back to the Aurignacian epoch are already known. Engraved figures are rare and so far as the head is concerned are little more than caricatures. The example from La Colombière is no exception in this respect and curiously enough resembles certain engraved human heads previously reported, one from the cavern of Font-de-Gaume (Dordogne), one from the Grotte des Fées (Gironde), and others from Les Combarelles (Dordogne) and Marsoulas (Haute-Garonne). In the Aurignacian layer were also found pebbles with engraved figures of the bison, *Felis*, horse, and wild sheep. When it is recalled that four fifths of all Quaternary engravings are animal figures, the bison and horse predominating, the importance of these two human figures from La Colombière at once becomes evident.

GEORGE GRANT MACCURDY

YALE UNIVERSITY

ON INTERFERENCE COLORS IN CLOUDS

THE writer has, for some time, noticed certain colors in clouds as they pass near the sun, and more careful observation indicates that an interesting effect is present which may not hitherto have been described. If the clouds within an angle of 15°, or so, from the sun are examined carefully, the sun, itself, being hidden by the corner of a

building or the roof of a piazza, certain parts of thin clouds, or edges of thick clouds, will usually be seen tinged with red or green, the colors often appearing together with red predominating. Occasionally the tint will be straw-color or purple. The effect may be seen at any time during the day, preferably when the sun is at a considerable elevation above the horizon. The colors are seldom intense, but are, nevertheless, very beautiful. They may be distinguished, when faint, by comparing them with any white cloud at an angle of 30° or 40° from the sun.

As the clouds in question are very brilliant, one's eyes have to become accustomed to the glare before the colors can be seen. Hence it is better to use smoked glass or dark glasses.[1] A smoked glass plate, on which the density of the smoke deposit varies from one edge to the other, is very convenient, as the best density for any particular cloud may quickly be found.

The following facts indicate that the mechanism of the effect is totally different from that by which the rainbow is produced. The colors appear in irregular patches of various sizes, and not in arcs of circles concentric with the sun. In fact, two small clouds may be close together, one being colored while the other is pure white. The red and green do not always appear together, the red occurring alone more frequently than the green. The same portion of cloud will frequently change from one color to the other.

It seems most reasonable to attribute these colors to interference. To make this clear, consider what must happen when white light passes through a water drop or ice crystal. At the surface where the light emerges, the ray will be divided, part passing through, and part being reflected back, to be reflected from the upper, or incident, surface of the drop, thence passing out through the lower surface. This second part will afford interference with the part of the ray that passed through unreflected, for a certain wave-length, provided a sufficient difference of phase, between the two parts of the ray, has been introduced. Owing to the shape of the drop, or particle, only one particular ray will, after undergoing this division, have *both* these parts sent in the direction of an observer on the ground (just as in the rainbow, each drop behaves like a prism, to an observer, but only for light that passes through one particular plane). If, further, we suppose that there are many drops of very closely the *same diameter*, then an observer should see light of the same color as that transmitted through a thin film, *e. g.*, a soap film or thin mica, of a thickness equal to this diameter.

[1] A solution of a substance, having transmission bands in the red and green only, would be best for observing the colors most frequently seen, namely, red and green.

Certain evidence supports the above explanation. The phenomenon is especially prominent in clouds that are increasing or decreasing in density. For example, in one particular cloud that was observed, which was increasing in size, the edge was first red, then green, then gray. Further, a cloud was occasionally seen with the red and green arranged in three or four alternate bands, strikingly suggestive of Newton's rings, or the fringes produced by an interferometer.

If the explanation here given is correct, these colors, besides of interest as being possibly the only sky colors produced by interference, may also be of some meteorological importance, namely; in giving an idea of the degree of homogeneity of size of drops in portions of thin clouds, by the intensity of the color; of the extent of these portions, by the area occupied by the color, and of the size of the drops, by the particular color present. Perhaps more information could be obtained by a spectroscopic method, whereby the spectrum of a small portion of cloud would show dark bands, corresponding to the wavelengths removed from the light by interference.

ROBERT H. GODDARD

WORCESTER, MASS.,
November 2, 1913

ORIGIN OF MUTATIONS

GATES, in a personal letter, has kindly called my attention to a misstatement contained in

my note[1] regarding the possible origin of mutations in somatic cells, in which I erroneously credited to Davis[2] the suggestion that triploid (semi-*gigas*) mutants of *Œnothera* are to be accounted for through the production of occasional diploid gametes by an extra fission of chromosomes. Obviously, as Gates points out, Davis's suggestion of diploid gametes could not have been offered as an explanation of triploid mutants, for the reason that the triploid condition in *Œnothera* was not known in 1911. Davis's suggestion was offered to account for the tetraploid condition of *gigas* mutants. The suggestion that tetraploid mutants may arise through a double fission of chromosomes in some mitosis soon after fertilization should have been credited to Gates.[3] I am grateful to Gates for setting me right in these matters.

R. A. Emerson

University of Nebraska

[1] *Amer. Nat.*, 47: 375, 1913.

[2] *Annals of Botany*, 25: 959, 1911.

[3] *Archiv f. Zellforsch.*, 3: 525, 1909.

HOW ORYCTES RHINOCEROS, A DYNASTID BEETLE, USES ITS HORN

Many beetles, particularly in the family Dynastidæ, have more or less conspicuous horns or processes on their head or prothorax. These often assume fantastic shapes and enormous proportions. Sometimes they occur on both sexes, but more often they are found only on the male or at least reach their greatest development there. In the latter case they have been looked upon by some as characters that may have been developed through sexual selection, the assumption being that males so ornamented were more attractive to the females or in some other way were more likely to be able to mate and thus perpetuate their kind. While such a theory may not be very satisfactory without more detailed observations or experiments to prove its soundness, we know of no other that is any more acceptable.

Many of the horns and projections are of such a size and character that it is hard to conceive of their being of any possible use to the insect in its struggle for food, or with its enemies. Possibly some of them are of no use in this way, but while studying the rhinoceros beetles, *Oryctes rhinoceros,* in Samoa last summer, I had an opportunity to watch these insects making a very evident and profitable use of the horn on their heads. The horn is present on both sexes and is usually longer on the male than on the female, but many males may be found with very short horns and many females with long horns, so that the sexes can not be separated by this character. The horns vary in length from 1.5 mm. to 10 mm., 6 or 7 mm. being about the average length. The beetles feed on the growing heart in the crown of the coconut trees. They usually enter the trees close to the base of a leaf, crawling down as far as they can between the tree and leaf-stem before beginning to bore. The spiny legs enable the beetle to brace itself firmly before it begins literally to root its way into the web-like sheath through which it usually has to pass before it reaches the hard wood. In doing this the head is lowered and the horn thus thrust forward. The horn becomes imbedded in the tissue of the plant and when it is raised serves as an anchor to hold the insect while it pulls or pushes its body forward with its legs, or while it tears the tissue of the plant with its heavy mandibles. The insect will always root and push its way as deep as it can before it begins to bore. The amount of power it can develop while trying to force its way between the bases of two leaves or in other tight places is truly remarkable.

Thus, in this instance at least, we see that this horn is of direct use in aiding the insect to reach its food.

R. W. Doane

Stanford University,
September, 1913

SCIENCE AND THE NEWSPAPER

While recently giving a discussion of the inclined plane, an idea which was new to me suddenly presented itself. The equation asserts that the force required to make a mass slide up the plane would under certain conditions be made less, by making the plane

steeper. A student reporter thought it to be his duty to announce to the newspaper world that a new law of physics had been discovered, and the importance of the discovery seems to have increased with each successive announcement.

This experience reminds me of a similar one which happened to me years ago. At the time when reporters everywhere were rushing to physics laboratories in order to learn something of X-rays, a reporter came to me. He found me experimenting with Hertz waves. By means of a large double-convex lens of wax, the waves were being brought to a focus upon a photographic plate enclosed in a wrapping of black paper. For several weeks I had been trying to produce a shadow picture upon the plate. The reporter seemed interested, and he seemed to have some intelligence. He could appreciate the evidence that the lens caused a refraction of the rays. Although he was informed in the most emphatic manner that this was not a refraction of X-rays, the public announcment was made that I had succeeded where others had failed, in the refraction of X-rays.

It seems to be impossible to quench a disturbance of this kind when it has once been emitted from a news-agency. Scientific readers have probably had enough of such experience to see the importance of keeping, in an accessible place, a few grains of salt.

Francis E. Nipher

THE INDUSTRIAL FELLOWSHIPS AT PITTSBURGH

To the Editor of Science: The industrial fellowship project, originated in the University of Kansas by Professor Robert K. Duncan and now in flourishing operation under his direction in the University of Pittsburgh under the name of the "Mellon Institute of Industrial Research and School of Specific Industries," has been more than once subjected to the criticism which found a place in an otherwise favorable reference in the presidential address of Mr. Arthur D. Little to the American Chemical Society at its recent meeting at Rochester:[1]

While some doubt may reasonably be expressed as to the possibility of close individual supervision of so many widely varying projects, the results obtained thus far seem entirely satisfactory to those behind the movement.

When first made this criticism had, I think, some validity. But to any one who has come into touch with the Mellon Institute, even as a visitor, it must be evident that the difficulty has been squarely met by "those behind the movement." The endowment of the fellowships is now so liberal as to permit of the employment of investigators of experience, who do not require "close individual supervision." In consequence, the relations of the Director and the Fellows are rather comparable to those of a university president and his corps of professors and instructors than to those of a university professor and his class of graduate students. Furthermore, the director is now assisted in the work of supervision by an associate director and an assistant director. Thus the services of three advisers are at the command of each Fellow, who may, moreover, obtain help from his colleagues without divulging the secrets of his own research.

If one acquainted with the project merely as an onlooker might venture an opinion upon the qualifications most essential to the success of the director of such an institute, it would be that a wide and sound general knowledge of scientific principles, a broad sympathy enabling one to appreciate the widely differing viewpoints of business men and of investigators and inventors, an active but disciplined scientific imagination and a strong, firm will are of more importance than an encyclopedic acquaintance with details.

J. F. Snell

Macdonald College
Quebec, Canada,
November 18, 1913

[1] Science, November 7, 1913, p. 652.

SCIENTIFIC BOOKS

Untersuchungen ueber Chlorophyll. Methoden und Ergebnisse von Richard Willstaetter und Arthur Stoll. Ein Bd., pp. 424, mit 16 Text-figuren und 11 Tafeln. Verlag von Julius Springer, Berlin. 1913. M. 18.00, geb M. 20.50.

If the well-known saying of Goethe "Denn eben wo es an Begriffen fehlt, da stellt ein Wort zur rechten Zeit sich ein" applied in the past to any group of phytochemical substances, its application to plant pigments was certainly justifiable. Such designations as "the green coloring matter of leaves," or "the blue coloring matter of flowers" are not as euphonious as chlorophyll and anthocyanin, but it is doubtful if they would have done as much harm. These words of Greek origin certainly enjoyed the advantage of brevity as well as of euphony, but they also carried with them something of a notion that they stood for more or less definite chemical compounds about which we flattered ourselves that we knew something, although this knowledge had not crystallized into structural formulas, the chemical shorthand expression of their properties. Plant physiologists were not the only sinners in this direction, but chemical literature is almost equally replete with illustrations of such misleading use.

To any one who is at all acquainted with the chemical literature on plant pigments, the researches of Willstaetter and his colaborers, as they have made their appearance in the *Annalen* since 1906, have come as a great relief. It is equally a relief, though of a different kind, to have the results, as laid down in these twenty-two Abhandlungen, together with more recent ones, coordinated to a "gemeinsames Ganzes." If we have admired Willstaetter's experimental researches, we are more grateful for his literary labors that have made available to us the results of his labors in the laboratory.

Even a partial review of the contents of this monograph would lead too far for a non-technical journal like SCIENCE. Suffice it to point out that all aspects of the subject, it would seem, are treated in such a manner that the person who desires to inform himself in a general way can use the book to advantage as well as the investigator who is particularly interested in this special field. Plant physiologists as well as chemists will find the volume replete with useful information as well as interest.

We have here another illustration of German "Gruendlichkeit" that is not impaired by specialization and detail, but that has accomplished the best because of special effort on the one hand and because of the application of a wide general knowledge to a restricted problem on the other hand. It reminds one of Berzelius's letter to Woehler in which the older Swedish chemist pats his young German friend on the back, as it were, when, in words that one would scarcely look for to a chemist, he makes light of the more or less accidental discovery of a new element by Sefstroem—a discovery that had just escaped Woehler—as compared with the brilliant and far-reaching researches of the man to whom is commonly attributed the first organic "synthesis."

If the Germans have felt the necessity of supplementing the research activities, that have so long been characteristic of the scientific institutes of their universities, by the Kaiser Wilhelm Foundation, this contribution from the "Kaiser Wilhelm-Institut fuer Chemie" may well serve as a good omen of the excellent results that may be expected in the future from this new institution devoted to scientific research.

If the knowledge that we now have to deal with definite chemical substances when we speak of the "Abbau" products of chlorophyll and its partial synthesis, affords a feeling of satisfaction, the excellent microphotographic views of the crystals of these substances assist in strengthening the feeling that our present knowledge, as elucidated by Willstaetter, rests on a good foundation. E. K.

The Principles of Stock-breeding. By JAMES WILSON, M.A., B.Sc., Professor of Agriculture in the Royal College of Science for Ireland, Dublin, author of "The Evolution of British Cattle and the Fashioning of Breeds." Published in 1912 by Vinton and Company, Ltd., 8 Bream's Buildings, Chancery Lane, E. C., London. 8vo. Pp. vi + 146.

This book is an exposition of the recently

discovered principles of heredity, and an attempt to demonstrate their utility in practical stock-breeding operations, with especial reference to the economic production of milk and butter. In the first chapters Professor Wilson develops, in a manner that should interest both the student of heredity and the practical breeder, the history of the theory of stock-breeding, beginning with the old theories, which he designates: "like begets like," "inbreeding," "pedigree" and "evolution." Concerning these theories he says, "They have been tried in Britain for varying periods of time: like begets like for centuries, inbreeding for nearly a century and a half, and pedigree for nearly a century. Evolution has been in stock-breeders' minds vaguely for nearly a half century." He describes the rise of each of these notions, and tells how each in turn was adopted by the practical breeders and how each in turn was found to possess exceptions and shortcomings which the breeder was bound to recognize. He then points out the manner in which the aggravating exceptions to these accepted principles led to further investigations, and finally to the discovery of other principles at first accepted all too inclusively, only to be subjected to the same purifying process.

The history of the making of the breeds of British cattle is always a fascinating story, and Professor Wilson, through his wide acquaintance with the history of breeding, describes the inestimable service rendered to livestock interests through the operations, largely by the process of inbreeding, first of all by Bakewell with many breeds, then by Hugh Watson with Angus cattle, and Cruickshank with Shorthorns, and by Sir George Macpherson Grant with Aberdeen-Angus cattle. The greatness of the English breeders is demonstrated by their willingness to try out all theories that promised utility. They threshed out the grain from the chaff; not only did they try out the old theories just mentioned, but they tried out with equal avidity "reversion," "maternal impression," "accident and mutilation" and "telegony." The fact that these latter theories yielded no "fruit" did not daunt the British breeder, and he is now in the midst of trying out Mendelism. If the principles of Mendelism, when applied to practical breeding, can yield half as much as the older inbreeding operations, then Professor Wilson's appeal and advice will prove to have been wholesome and good.

There is in this book a vigorous protest against pedigree breeding in the old sense, and a continual appeal for breeding for traits which can be controlled by the applications of Mendelian principles. The author contends that the herd-books and stud-books are the tyrants that keep modern breeds stationary; that fashion, as much as utility, seems to rule the older breeds, the one exception being the thoroughbred horse, which is continually being put to the best of tests, namely, the track, and winners and breeders of winners are in demand regardless of family tradition. He prophesies that one of the principal lines of development of stock-breeding in the future will be the transferring of traits of utility from one breed to another, and is optimistic as to the possibilities of such a process.

The author describes the instances wherein traits of domestic animals appear to behave in Mendelian fashion, and he attempts to give practical advice as to the proper method of breeding for what he is pleased to call the three economic factors, namely, size, yield and quality.

In reference to the first, size, it appears that the first cross between cattle of a small and a large breed will give, quite uniformly, an intermediate-sized animal, but it is not clear whether such animals when bred together will throw offspring which segregate back to the two grandparental sizes. He protests against the method of breeding the half-breed offspring back to one of the pure breeds, claiming, quite properly it appears, that the correct way to secure new combinations is to breed the F_1 hybrids together. He protests also against too close an adherence to the theory of fancy points, holding that there is not always the high correlation between fashionable points and utility that many breeders seem to feel exists.

In discussing the second factor, the quality of milk yield, the author describes an experiment conducted by Count Ahlefeldt, wherein Red Danish cattle, with an average yield of 3.42 per cent. milk, were crossed with Jerseys averaging a yield of 5.22 per cent. milk. The hybrid offspring averaged a yield of 4.15 per cent. These cross-bred animals were bred back to the parental Jerseys. The author points out that if quality of yield behaves in Mendelian fashion, one half of the animals, regardless of their other traits, would yield milk of Jersey quality, and one half of them would yield the cross-breed quality. Analyzing the table given by the author, we find that of the 15 offspring of such matings 7 yielded 4.7 per cent. or richer milk, and 8 yielded below this quality. If the types of offspring from the *Cross* by *Red Danish,* and *Cross* by *Cross* matings approximate as closely to the Mendelian expectation as the *Cross* by *Jersey* mating just described, and the matings are extensively made, then, even though yield may be governed by a host of unit traits, they would appear, for practical purposes, to move in synchronism, and the practical breeder would have a working principle of value. One would suspect, however, that such a complex thing as quality would shatter in the subsequent inbreeding of hybrids. More data are required.

The author points out that yield of butter is not a fair basis for breeding selection, because butter yield is dependent upon two factors, namely, quality and quantity of milk. Each one of these factors should be taken as a basis for selection, and a combination of high quality and high yield sought by Mendelian methods. He sees no sound reason why high quality and great quantity of yield should be mutually exclusive; he believes they can be combined by Mendelizing.

If any adverse criticism were to be rendered, it must be said that throughout the book the author disregards the exceptions to the rule when describing the heredity of an animal characteristic which appears to approximate Mendelian expectation. For instance, continual reference is made to color inheritance in Shorthorn cattle, assuming the case exactly parallel to that of the Andalusian fowl, wherein the first generation hybrid is a blend and segregation occurs in the second generation according to Mendelian formula. Whereas it has been found that Shorthorn coat color is neither one unit nor a single group of units, but behaves in heredity as two units, or unit groups, the areas for the white hairs in the roan behaving as one unit, and the areas for the red as another. Moreover, a red mated with a red does not *always* produce a red, although it *generally* does so. If the whole coat color were a single unit, behaving in Mendelian fashion, then *red* by *red* would produce only red. To a well-known exception of this sort the author should not be blind; to him, as he so clearly points out in reference to the older studies and theories, it should point toward future studies and discoveries, each with its gold and dross. It would seem more reasonable continually to urge the analysis of gross somatic characteristics into heritable units which, without exception, behave according to rule. However, a rule that works nine times out of ten is a good one for the practical man to follow, and to him is an instrument of inestimable value, although to the theorist the one exception is the thing that commands his interest and work.

To summarize, the book is a special plea for the practical application of the Mendelian principles to animal breeding, and as such, the case is better established than in any other practical breeder's guide with which the reviewer is acquainted. In general, it recognizes the limitations of the present knowledge of Mendelian traits in domestic animals, and in a wholesome manner urges further investigation, as well as the courageous application of current theories by practical breeders.

The author's style is literary, his English clear, and his argument is easy to follow.

H. H. Laughlin

Eugenics Record Office,
Cold Spring Harbor, Long Island

The First Principles of Evolution. By S. Herbert. London, A. & C. Black; New York, The Macmillan Co. 1918.

Notwithstanding the large number of books that have already been published on evolution, the author of the above work believes that there is still a need for another which will present the subject, not as a theory that is on trial, but as an established principle in terms of which men must be taught to think. The popular tendency to regard evolution and Darwinism as synonymous terms is the result of the historical development of the theory largely on the basis of facts derived from organic nature, and its wider application as a philosophical principle has been thereby obscured. To correct this misconception the earlier chapters of the present work are devoted to an exposition of cosmic, geological and atomic evolution, this last leading to a brief and rather inadequate consideration of the origin of life, whence there is a natural transition to the discussion of organic evolution. Unfortunately, however, for the broader conception which the author seeks to emphasize, this last and more familiar side of the subject is given more than three times the amount of space granted inorganic evolution and this is all the more regrettable since the treatment of organic evolution does not compare altogether favorably with that to be found in other familiar works which naturally suggest themselves, especially since the illustrations are merely reproductions of well-known figures from Darwin, Wallace, Weismann and especially Romanes. Credit must be given, however, for a clear and concise statement of the various theories that have been advanced as an explanation for organic evolution, Darwinism and Neo-Darwinism, Lamarckism and Neo-Lamarckism, mutations, orthogenesis, entelechies, Bathmism and even the metaphysical subtleties of Bergson being briefly expounded and criticized.

The last hundred pages of the book are devoted to what the author terms superorganic evolution, under which heading are discussed mental, moral and social evolution, sufficient being said upon each of these topics to give the reader a fair idea of the trend of modern thought in connection with questions of the utmost importance to society.

The book is one that may be sincerely recommended. Like an earlier work by Dr. Herbert, "The First Principles of Heredity," it is the outcome of a series of lectures delivered to popular audiences, and, while clear and concise in statement, it is excellent reading. A well-selected bibliography is appended and also a glossary of unavoidable technical terms.

J. P. McM.

SPECIAL ARTICLES

ON FUNDAMENTAL METHODS OF ORIENTATION AND "IMAGINARY MAPS"

THE following paper presents a study of the reasons why civilized man is so apt to lose his bearings in unfamiliar regions. This question of orientation apparently has been neglected heretofore.

In an investigation of the "sense of direction" or the "sense of locality," it is important to classify the fundamental methods of orientation employed by living creatures. There appear to be two radically different methods; one used by civilized man, the other chiefly by living creatures of a lower order. The former, which employs the points of the compass, is acquired artificially by education. It is proposed to call this the *ego-centric method.* The latter is used not only by birds, beasts, fish, insects, etc., but also, in all probability, by young children and by a large proportion of mankind living in an uncivilized state. In this system of orientation the points of the compass play little, if any, part, and it may be designated as the *domi-centric method.* The selection of these terms by the author will be explained below.

The Ego-centric Method of Orientation.—Civilized man, by artificial training, has become accustomed to orient himself by the four points of the compass: north, east, south and west; and indeed wherever he may be, he usually finds his way by this method, except in the neighborhood of his dwelling place. In the immediate vicinity of the home the orientation nearly always relates to the home as a center of reference, irrespective of the points of the compass, and in this limited region the

method of orientation is largely domi-centric.

The orientation reference points in the *ego-centric method* are points on the horizon corresponding to the directions N., E., S. and W. Lines from these points always intersect at the ego, the intersection moving with the ego; hence the basis for the term given to this system of orientation.

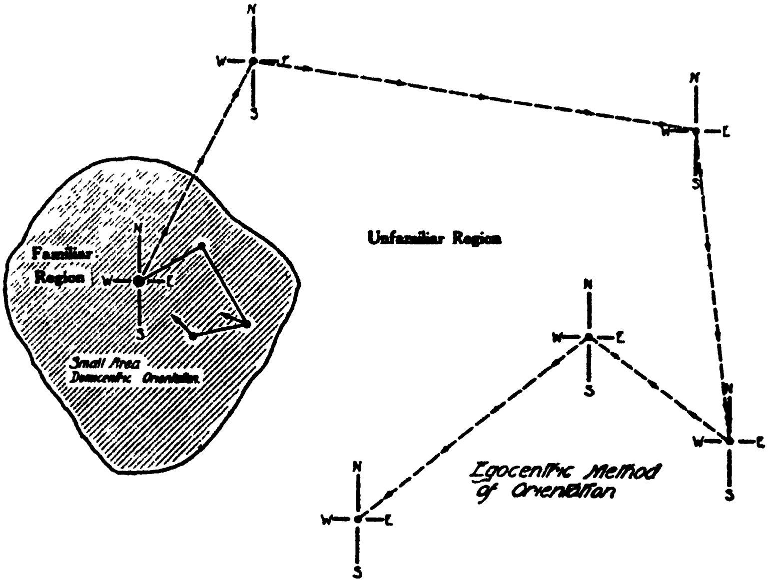


FIG. 1. Ego-centric Method of Orientation. In the unfamiliar region the reference points are objects or points on the horizon corresponding to the direction N., E., S. or W.

It is, of course, well known that when a man is wandering through any maze-like region, such as a primeval forest, the compass gives the direction from the man toward the north, or more strictly, the north magnetic pole, and to all other parts of the compass, but not the direction to the man's starting point; thus the ego-centric method is not a system *per se* which will direct the individual to his home. This system of orientation, therefore, (*a*) leads man to think of space in relation to the cardinal points of the compass; (*b*) it can be used to direct an individual home only when the path which he has passed over is known. The method is illustrated by Fig. 1.

The Domi-Centric Method of Orientation.—All living creatures, other than civilized man, having no knowledge of the points of the compass as such, or of the extent of the world, know only the region which they have traversed. Thus it follows that from the time these creatures come into existence their movements, instead of being referred to points of the compass, relate to the place where they began their existence, and hence in early life their knowledge of space must necessarily be related to the place of birth. This system of orientation, centering at the home and irrespective of the points of compass, has been called the *domi-centric method*, and is illustrated by Fig. 2. The Esquimaux, Indians, etc., evidently have a method of orientation which is not definitely in any one class, but is rather a combination of the two methods already mentioned.

If the home of any animal is changed for a considerable period of time to a region away from its former habitation, thenceforth all movements will be referred to the last principal reference point, or home. In this case the *domi-center* has changed.

It is well here to emphasize the entirely different mental concept of civilized human beings, on the one hand, and of other living

creatures, on the other, relating to space on the earth's surface. The former look outward towards the horizon, the latter look backward toward their starting point. To the first no opportunity is offered for expertness through experience, to the second is given an opportunity for a reflex mechanism. In the ego-centric method, it is as if the man were attached to the four cardinal points of the compass by elastic threads of indefinite lengths, which present no basis whatever (lines or angles) for a trigonometric figure that relates to the home.

responsible at times for man's confusion when attempting to find his way, as will be shown. In the other, the domi-centric system of orientation, experience continually leads an animal to greater expertness in finding its way home, and the conditions are present for a reflex mechanism.

The Imaginary Orientation Map.—There is a feature of the *ego-centric method* of orientation which seems to show that the use of this system leads to loss of bearings. It is found that either through loose early education or through later impressions persons

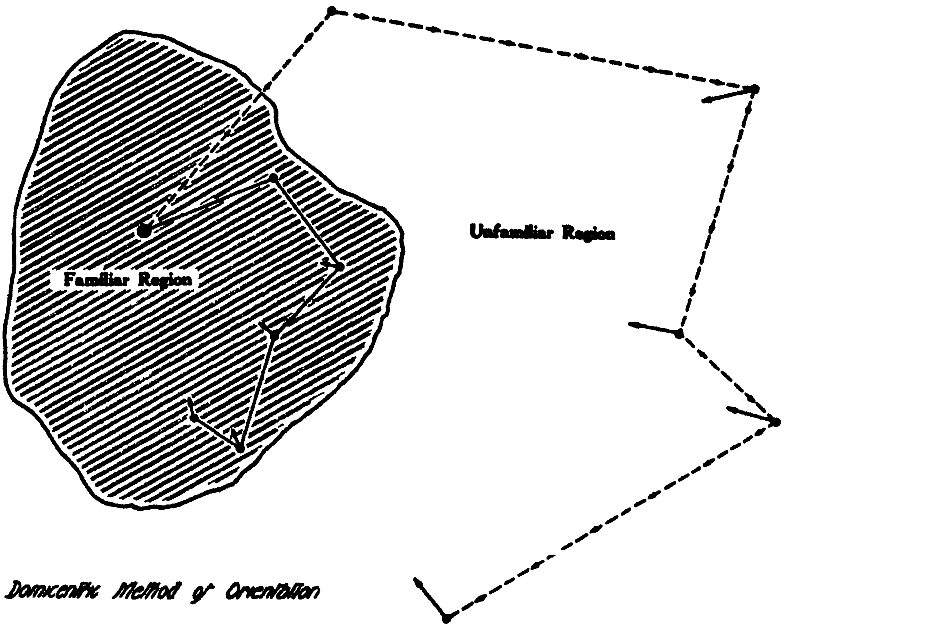


FIG. 2. Domi-centric Method of Orientation. The chief reference point is always the starting point, or home. Around about are usually many minor reference points; familiar objects which give a definite reaction relating to the home.

In the case of insects, birds, mammals, etc., which orient themselves domi-centrically, it is as if the living creature were attached to its home by one very strong elastic thread of *definite* length. Hence, in this case, all changes of position of the creatures can be referred at any moment, to definite distances and angles, forming a simple trigonometric figure which gives the direction to the home.

In the two types of orientation methods, the use of one, the ego-centric system, actually is

are apt to acquire erroneous ideas of the directions *toward very distant places of the earth,* frequently becoming gradually accustomed to think of the points of the compass which correspond to these distant places with a large error of direction, amounting in some cases to as much as 180°, or diametrically opposite to the correct location. This leads to the conception of a mental image of an orientation map that is entirely imaginary, and erroneous. This imaginary orientation map appears to be

similar to, if not actually connected with, punctuation, the visualization process. It will be found by questioning various individuals, that the orientation of many persons for very far distant points, as they usually think of these places, is in error to the extent of 30°, 90° or even 180° (or half circle). Fig. 3 is a diagram drawn to illustrate what is meant by an "imaginary map." In this figure the solid lines represent the map as it actually is. The dotted lines represent the map as the subject is accustomed to think of it. An important fact in this connection has been found, namely, that those individuals who have "imaginary maps," are readily confused in regard to locality, are apt to become lost in the forests, and usually are subject to confusion as to direction when emerging from theaters, subways, etc. On the other hand, those individuals who through careful early education or from travel are accustomed to *think* of far distant places in the proper directions, are much less apt to be confused in regard to locality. This is readily evident from the accompanying statistics. An extensive analysis of the precise forms of the erroneous conceptions with respect to the direction toward distant places has not been attempted. A few of the more common types will be given which will help to emphasize the fact that this so-called imaginary map which accompanies the "ego-centric" or cardinal point method of orientation unquestionably contributes to the difficulty that man experiences in finding his way home in an unfamiliar region.

Various Types of Imaginary Maps.—The common types are described below. A complete classification would be difficult since the types must grade into one another, but most of those mentioned appear to be common forms.

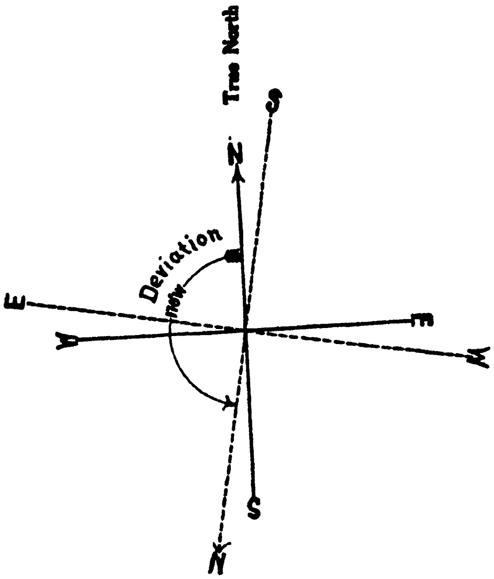


FIG. 3. Diagram to Explain the Imaginary Orientation Map. The solid lines indicate the points of the compass, and is the map which the subject knows to be correct. The dotted lines indicate the map as the subject is accustomed to think of it when far distant places are casually thought of.

The types will be classed as individuals.

Type A.—Those persons who have an "imaginary map" of fairly consistent "deviation" from the correct direction for the entire circuit of the compass. (A common type.) The "deviation" refers to very distant places, and in this class amounts to from 20° to 180°. It is the angle between the true directions of distant places and the directions that the subject casually thinks these places lie in.

Type B.—Those who have different "imaginary maps" in different localities. The following example of an actual case will illustrate

this type, which should include different parts of a large city as well as different localities in the country.

The map of E. F. H. represents a noteworthy case of Type *B*, but probably not uncommon. His average deviation (for distant places) at 116th Street in the City of New York is 156° west, the average variation of the mean of one set of observations of four distant places being only 5°. At 42d Street in the same city, his imaginary map is about 90° wrong, that is, the deviation is 90°, and at 14th Street the imaginary map disappears. Likewise his orientation is 90° wrong at Toronto, Canada, correct at Chicago, and nearly correct in country districts away from cities. Mr. E. F. H. is almost always confused as to the direction toward his home when coming out of theaters and often when coming out of subways.

Type C.—Those who imagine north as directly in front of them. Thus the deviation of the imaginary map is determined entirely by the direction in which they may be facing, the east being at the right hand, the west left hand. The imaginary map is consistent, that is, all places have nearly the correct relation to the north, and turns with the subject. (Common type.)

Type D.—Those to whom *all distant* points lie either toward the west or toward the east. For example *both* Madrid and San Francisco appear to lie to the west from an individual of this class residing in New York City. (Two well-defined cases.)

Type E.—Those who think of far distant points in approximately the correct direction, but to whom distant countries appear rotated. For example, to one individual while England appears in approximately the correct direction from New York, the entire British Islands are rotated about 180°; both the English Channel and France appearing to lie to the north of the British Isles. (One case.)

Type F.—Those who have an imaginary map that differs consistently about 20–40 degrees from the correct one, apparently due to the influence of the direction of certain rivers and streets which for one reason and another have had a marked orientation influence on the subject. (Several cases.) It is possible that this is the same as type *A*; yet the cause of the confusion appears to be different.

Type G.—Those having an imaginary map that always makes certain streets in every city exactly north and south, others exactly east and west, with all diagonal streets 45°, as if lying northeast and southwest, or northwest and southeast. (Several cases.)

Another type is that of a person who has had an imaginary map, but who has gradually overcome it by education. In one case the subject had an imaginary map for four years while at college. At the present time in various cities, he is usually confused when coming out of theaters, etc., and it is possible that the former imaginary map is still latent and is frequently a source of confusion. There are other features of imaginary maps that do not so directly bear on the question of orientation. For example, there is one individual who always thinks of, or visualizes Europe as if it were but 20 to 40 miles off the Atlantic coast. Then, of course, the majority of people think of distant places as points on a plane, no allowance being made for the curvature of the earth.

Explanation and Importance of Imaginary Maps.—All of the above types, *A–G*, are taken from actual cases, the subjects being as a rule of very high type of intellectuality, university professors, graduate students, etc. The explanation which seems to be the most plausible one to account for this so-called "imaginary map," is the persistence of early erroneous impressions concerning the direction of far distant places with respect to the home, the mistaken ideas arising from various causes. These impressions apparently take a firm hold during childhood. The matter is of some importance, since it accounts in a measure for the readiness of man to be confused with respect to a new environment, and to become "lost" in the woods or in any maze-like surrounding. An example of a practical bearing is as follows: The matter has a pertinent relation to the training of children who are to become soldiers, especially in countries where standing armies are maintained. In times of war, it is not im-

probable that the loss of more than one battle has been due to the utter confusion of officers or of small bodies of troops with respect to points of compass, due to the concentration of attention on the enemy in the height of action or during maneuvers at night.

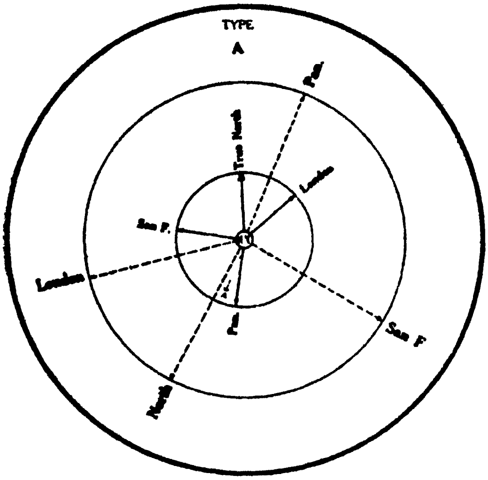


FIG. 4. Type A. Imaginary Map. The amount of deviation is the same amount under all conditions, and in all places.

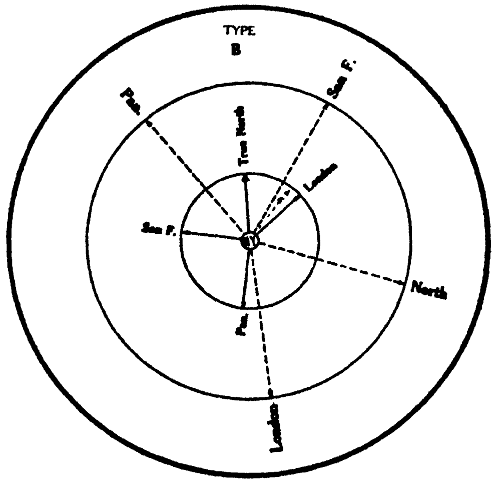


FIG. 5. Type B. Imaginary Map. The amount of deviation may vary with the place in which the subject happens to be.

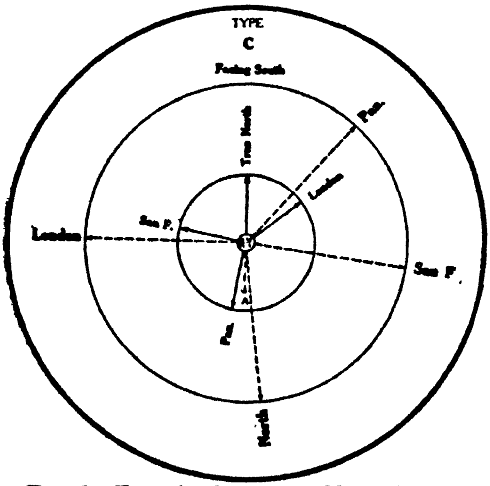


FIG. 6. Type C. Imaginary Map. The map depends on which way the subject is facing.

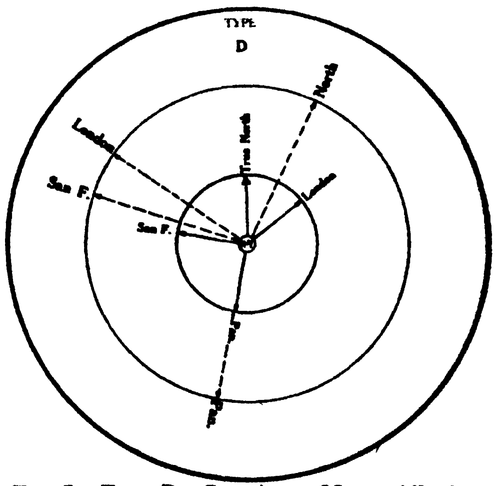


FIG. 7. Type D. Imaginary Map. All distant places appear to be west (or east) of north.

If it is desirable to correct this very common defect in orientation training, it would appear necessary that children should be seated at school in a special manner when studying geography, with the cardinal points of the compass marked in the room, and the maps in the books properly orientated, and the imaginary maps systematically corrected in childhood.

The proportion of people who have so-called "imaginary maps" is astonishingly large, being of the order of thirty to fifty per cent., if not a much higher ratio; hence the matter is one of general interest.

The object of the presentation of these facts

is to show that children of civilized parents, through accidental faults in early education arising from the faculty of vivid imagination, and owing to the misuse of the "*ego-centric*" or cardinal point method of orientation, build up persistent impressions quite erroneous, which later on in life unconsciously affect their judgment when attempting to find their way in unfamiliar regions and lead to utter confusion with respect to the way home. Examples of this effect are common.

In the tests made by the author it is interesting to note that almost every subject who had an "imaginary map" for far distant places, gave the direction from New York towards Albany, N. Y., nearly correct. Albany is about 90 miles from New York. This indicates that the education gradually fixes in thought the correct direction toward places, finally overshadowing the influence of the "imaginary map." The position of the Hudson River with respect to New York probably is an important factor in correctly fixing this particular direction.

It must be distinctly understood that the directions in "imaginary maps" are not as the subject knows the directions to be, but merely where they always imagine them as being in the ordinary process of thinking, and *in all cases referred to in the present discussion the subject having an imaginary map, knew the correct directions approximately.* The "imaginary map" is thus superimposed on the real map, or it may be said that the subject has two maps; one approximately correct, the other entirely imaginary.

Statistical Data.—Some statistics are given in Tables I. to V. The subjects on whose orientation data the tables are based were all persons of university training. Table I. contains ten cases of imaginary maps as determined by the directions towards four far distant places. Four of these maps are given diagrammatically in Figs. 4, 5, 6 and 7, representing different types which have been classified as *A, B, C* and *D,* respectively. In Table II. is given the mean error and average variation of the observations recorded in Table I.

Table III. contains ten cases of subjects having no imaginary maps and includes the angular deviation from the correct directions. It is seen that there may be very large errors in some cases in locating the direction towards the places selected for the test. All the subjects in Table III. had but one orientation map, however, while those in Table I. have two.

In Table IV. the mean error and average variation of the observations in Table III. are given in a manner similar to Table II.

It seemed desirable to select at random ten subjects not having imaginary maps, and then to determine their orientation accuracy in each case by asking them to locate the directions towards the cardinal points of the compass. This was done, and it was found that astonishingly large errors were recorded in a few cases, as shown in Table V. The average error was 30°, and the mean of these errors with respect to north was 22.6° clockwise (eastward). All but two showed a decided clockwise error, which was accounted for by reason of the prevailing idea that the chief avenues in New York lie approximately north and south. Actually they lie 29 degrees (clockwise) from the meridian, that is, the azimuth of the longitudinal streets of Manhattan is N. 29° E.

In the tables the record in degrees given was based on but one observation. By a special test it was found that the deviation readings always varied a few degrees; some considerably more; therefore, the readings given in the tables should be understood to indicate the approximate deviation angle only.

In a few cases errors were made due to magnetic disturbances of the compass when checking up the charts, but these have no significance in the article, therefore, they are at present disregarded.

The method of obtaining the data relating to "imaginary maps" was as follows: A circular piece of paper was placed before a subject, who was requested to mark on the disk the directions from the center of the disk, New York, N. Y., to the North Pole, London, San Francisco and Panama, as these places appeared to him. The magnetic north was then

TABLE I

Deviation of Subjects Having Imaginary Maps

Name	Place Located	Deviation from Correct Location	Type
J. C. H.[1]	North Pole	154° counter-clockwise	*A*
	London	70° counter-clockwise	
	Panama	86° counter-clockwise	
	San Francisco	31° counter-clockwise	
J. M.	North Pole	110° clockwise	*A*
	London	126° clockwise	
	Panama	134° clockwise	
	San Francisco	111° clockwise	
C. G. S.[2]	North Pole	42° clockwise	*A*
	London	82° clockwise	
	Panama	29° clockwise	
	San Francisco	21° clockwise	
C. C. T.[1]	North Pole	138° counter-clockwise	*A*
	London	126° counter-clockwise	
	Panama	134° counter-clockwise	
	San Francisco	150° counter-clockwise	
R. C.[1]	North Pole	117° clockwise	*A*
	London	156° clockwise	
	Panama	121° clockwise	
	San Francisco	107° clockwise	
B. R. R.[1]	North Pole	79° clockwise	*A*
	London	117° clockwise	
	Panama	108° clockwise	
	San Francisco	78° clockwise	
E. F. H.[1]	North Pole	149° counter-clockwise	*B*
	London	153° counter-clockwise	
	Panama	165° counter-clockwise	
	San Francisco	157° counter-clockwise	
W. A. H.[1]	North Pole	175° clockwise	*C*
	London	139° counter-clockwise	
	Panama	149° counter-clockwise	
	San Francisco	177° clockwise	
P. C.[1]	North Pole	49° counter-clockwise	*C*
	London	11° clockwise	
	Panama	93° counter-clockwise	
	San Francisco	124° counter-clockwise	
J. D.[1]	North Pole	26° clockwise	*D*
	London	106° counter-clockwise	
	Panama	1° clockwise	
	San Francisco	8° clockwise	
R. R.[1]	North Pole	21° clockwise	*H* (perhaps type *D*)
	London	151° clockwise	
	Panama	60° clockwise	
	San Francisco	26° clockwise	

obtained by a compass and marked on the disk. The true north was ascertained later.

The correct direction from New York, N. Y., to the distant points above mentioned was obtained from one of the staff of the American Geographical Society who made the necessary calculations. They were as follows:

North Pole	0° 0′	
London	51° 10′	(51° 10′ east of north).
Panama	190° 20′	(10° 20′ west of south).
San Francisco	281° 25′	(78° 35′ west of north).
Albany, N. Y.	4° 59′	(4° 59′ east of north).

The percentage of individuals having the so-called imaginary map can only be decided by extensive data on the subject, but in order to learn the approximate ratio in a certain class, twenty-seven persons, taken at random, were questioned. The results were as follows:

Total number of persons (males) consulted	27
Those having "imaginary maps"	16
Those having no "imaginary maps"	8
Cases that were uncertain	3

Of the 16 having "imaginary maps" 14 were more or less confused when coming out of theaters, subways, etc.

Of the 8 having no "imaginary maps," 7 were not confused when coming from theater and had in general a good "sense of direction." (These ratios are similar to those in Tables I. and III.).

According to these figures, the number of persons in 27 having "imaginary maps" was about 59 per cent. These statistics are far too few on which to base any general conclusions other than the prevalence and importance of this curious so-called "imaginary map."

Certain physiological effects connected with this matter are of interest; Yves Delage has touched upon the subject in his "Essay on the Constitution of Ideas." He states that when he is "turned around" or confused in regard to direction, he feels a sensation of illness at the moment of rectification of his notions.

[1] Subject is confused as to directions on coming out of theaters and subways.

[2] Subject is not usually confused as to directions on coming out of theaters and subways.

Henri de Varigny in the "Revue des Sciences" of the *Journal des Débats* (Paris, April 17, 1913), discussing the above essay, states that under the same circumstances he has an impression like a slight vertigo, the feeling being localized clearly at the base of the skull.

The work in this investigation has been aided by a grant by the New York Academy of Sciences from the Esther Herman Fund.

TABLE II

Average Error and Variation in the Case of those Subjects Having Imaginary Maps

Name	Mean Error of Four Places Located	Average Variation from Mean	Type
J. C. H., Jr.	85° counter-clockwise	35°	*A*
J. M.	120° clockwise	10°	*A*
C. G. S.	44° clockwise	20°	*A*
C. C. T.	137° counter-clockwise	7°	*A*
R. C., Jr.	125° clockwise	15°	*A*
B. R. R.	96° clockwise	17°	*A*
E. F. H.	156° counter-clockwise	5°	*B*
W. A. H.	160° [3]	16°	*C*
P. C.	69° [3]	39°	*C*
J. D.	35° [3]	35°	*D*
R. R.	64° clockwise	43°	*H*

Column 2 gives the average angle between the true directions of distant places and the directions in which the subject thinks these places lie.

Column 3 indicates the inconstancy of this angular displacement or deviation.

TABLE III

Deviation of Subjects who have No Imaginary Maps

Name	Place Located		Deviation from Correct Location
H. C.	North Pole	?	(chart confused).
	London	5°	clockwise.
	Panama	11°	clockwise.
	San Francisco	23°	counter-clockwise.
E. L. K.[4]	North Pole	0°	
	London	21°	clockwise.
	Panama	10°	counter-clockwise.
	San Francisco	20°	counter-clockwise.
J. H. M.[4]	North Pole	6°	clockwise.
	London	31°	clockwise.
	Panama	18°	counter-clockwise.
	San Francisco	16°	counter-clockwise.
E. F. K.[4]	North Pole	14°	clockwise.
	London	43°	clockwise.
	Panama	4°	counter-clockwise.
	San Francisco	14°	clockwise.
W. H. G.[5]	North Pole	14°	clockwise.
	London	41°	clockwise.
	Panama	6°	counter-clockwise.
	San Francisco	14°	clockwise.
H. W. W.[4]	North Pole	28°	clockwise.
	London	32°	clockwise.
	Panama	26°	clockwise.
	San Francisco	18°	clockwise.
H. M. R.[4]	North Pole	8°	counter-clockwise.
	London	4°	clockwise.
	Panama	36°	counter-clockwise.
	San Francisco	31°	counter-clockwise.
F. B.[5]	North Pole	8°	clockwise.
	London	17°	clockwise.
	Panama	4°	clockwise.
	San Francisco	14°	counter-clockwise.
W. A. D.	North Pole	34°	clockwise.
	London	48°	clockwise.
	Panama	2°	counter-clockwise.
	San Francisco	16°	clockwise.
J. C. G.[4]	North Pole	4°	counter-clockwise.
	London	8°	clockwise.
	Panama	13°	counter-clockwise.
	San Francisco	20°	counter-clockwise.

[3] Some errors clockwise, others counter-clockwise. See Table I.

TABLE IV

Average Error and Variation in the Case of Those Subjects Having No Imaginary Maps

Name	Mean Error of Four Places Located	Average Variation from Mean
H. C.	13° [6]	7°
E. L. K.	13° [6]	8°
J. H. M.	18° [6]	7°
E. F. K.	19° [6]	12°
W. H. G.	19° [6]	11°
H. W. W.	26° clockwise	4°
H. M. R.	20° [6]	14°
F. B.	11° [6]	5°
W. A. D.	25° [6]	16°
J. C. G.	11° [6]	5°

[4] Subject is not usually confused as to directions on coming out of theaters and subways.

[5] Subject is confused as to directions on coming out of theaters and subways.

[6] Some errors clockwise, others counter-clockwise. See Table III.

TABLE V

Errors in Locating the Cardinal Points of the Compass in the Case of Subjects Having No Imaginary Maps

Name	Direction	Deviation from Correct Direction	Mean Deviation or Error
W. S. N.	North	5° clockwise	24°
	East	37° clockwise	
	South	34° clockwise	
	West	18° clockwise	
R. M.	North	31° counter-clockwise	31°
	East	34° counter-clockwise	
	South	29° counter-clockwise	
	West	31° counter-clockwise	
F. N. C.	North	8° counter-clockwise	7°
	East	8° counter-clockwise	
	South	7° counter-clockwise	
	West	3° counter-clockwise	
W. A. D.	North	34° clockwise	1°
	East	34° clockwise	
	South	31° clockwise	
	West	25° clockwise	
A. C. M.	North	25° clockwise	22°
	East	19° clockwise	
	South	22° clockwise	
	West	23° clockwise	
T. E. H.	North	12° clockwise	15°
	East	5° clockwise	
	South	19° clockwise	
	West	22° clockwise	
H. F. J.	North	19° clockwise	22°
	East	24° clockwise	
	South	20° clockwise	
	West	25° clockwise	
G. F. W	North	79° clockwise	85°
	East	84° clockwise	
	South	88° clockwise	
	West	8[illegible]° clockwise	
J. M. G.	North	52° clockwise	56°
	East	57° clockwise	
	South	59° clockwise	
	West	57° clockwise	
W. W. R.	North	11° clockwise	9°
	East	14° clockwise	
	South	2° clockwise	
	West	10° clockwise	

C. C. TROWBRIDGE

COLUMBIA UNIVERSITY

THE CONVOCATION WEEK MEETING OF SCIENTIFIC SOCIETIES

THE American Association for the Advancement of Science and the national scientific societies named below will meet at Atlanta, Ga., during convocation week, beginning on December 29, 1913.

American Association for the Advancement of Science.—President, Professor Edmund B. Wilson, Columbia University; retiring president, Professor Edward C. Pickering, Harvard College Observatory; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.; general secretary, Professor Harry W. Springsteen, Western Reserve University, Cleveland, Ohio; secretary of the council, Professor William A. Worsham, Jr., State College of Agriculture, Athens, Ga.

Section A—Mathematics and Astronomy.—Vice-president, Dr. Frank Schlesinger, Allegheny Observatory; secretary, Professor Forest R. Moulton, University of Chicago, Chicago, Ill.

Section B—Physics.—Vice-president, Professor Alfred D. Cole, Ohio State University; secretary, Dr. W. J. Humphreys, Mount Weather, Va.

Section C—Chemistry.—Vice-president, Dr. Carl L. Alsberg, Bureau of Chemistry; secretary, Dr. John Johnston, Geophysical Laboratory, Washington, D. C.

Section D—Mechanical Science and Engineering.—Vice-president, Dr. O. P. Hood, U. S. Bureau of Mines; secretary, Professor Arthur H. Blanchard, Columbia University, New York City.

Section E—Geology and Geography.—Vice-president, J. S. Diller, U. S. Geological Survey; secretary, Professor George F. Kay, University of Iowa.

Section F—Zoology.—Vice-president, Dr. Alfred G. Mayer, Carnegie Institution of Washington; secretary, Professor Herbert V. Neal, Tufts College, Mass.

Section G—Botany.—Vice-president, Professor Henry C. Cowles, University of Chicago; secretary, Professor W. J. V. Osterhout, Harvard University, Cambridge, Mass.

Section H—Anthropology and Psychology.—Vice-president, Professor Walter B. Pillsbury, University of Michigan; acting secretary, Dr. E. K. Strong, Jr., Columbia University, New York City.

Section I—Social and Economic Science.—Vice-president, Judson G. Wall, Tax Commissioner, New York City; secretary, Seymour C. Loomis, 69 Church St., New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor Theodore Hough,

University of Virginia; secretary, Dr. Donald R. Hooker, Johns Hopkins Medical School, Baltimore, Md.

Section L—Education.—Vice-president, Dr. Philander P. Claxton, Commissioner of Education, Washington, D. C.; secretary, Dr. Stuart A. Courtis, Liggett School, Detroit, Mich.

The Astronomical and Astrophysical Society of America.—December 29–January 3. President, Professor E. C. Pickering, Harvard College Observatory; secretary, Professor Philip Fox, Dearborn Observatory, Evanston, Ill.

The American Physical Society.—December 29–January 3. President, Professor B. O. Peirce, Harvard University; secretary, Professor A. D. Cole, Ohio State University, Columbus, Ohio.

The American Federation of Teachers of the Mathematical and the Natural Sciences.—Between December 30. President, Professor C. R. Mann, University of Chicago; secretary, Dr. Wm. A. Hedrick, Washington, D. C.

The Entomological Society of America.—December 30–31. President, Dr. C. J. S. Bethune, Ontario Agricultural College; secretary, Professor Alexander D. MacGillivray, 603 West Michigan Ave., Urbana, Ill.

The American Association of Economic Entomologists.—December 31–January 2. President, Professor P. J. Parrott, Geneva, N. Y.; secretary, A. F. Burgess, Melrose Highlands, Mass.

The Botanical Society of America.—December 30–January 2. President, Professor D. H. Campbell, Stanford University; secretary, Dr. George T. Moore, Botanical Garden, St. Louis, Mo.

The American Phytopathological Society.—December 30–January 2. President, F. C. Stewart, Agricultural Experiment Station, Geneva, N. Y.; secretary, Dr. C. L. Shear, Department of Agriculture, Washington, D. C.

The American Microscopical Society.—December 30. Secretary, T. W. Galloway, James Millikin University, Decatur, Ill.

American Association of Official Horticultural Inspectors.—December 29. President, E. L. Worsham, Atlanta, Ga.; secretary, J. G. Saunders, Madison, Wis.

The Southern Society for Philosophy and Psychology.—December 31–January 1. President, Professor H. J. Pearce, Gainesville, Ga.; secretary, Professor W. C. Ruediger, George Washington University, Washington, D. C.

The Sigma Xi Convention.—December 30. President, Professor J. McKeen Cattell, Columbia University; recording secretary, Professor Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Gamma Alpha Graduate Scientific Fraternity.—December 30. President, Professor J. I. Tracey, Yale University; secretary, Professor H. E. Howe, Randolph-Macon College, Ashland, Va.

PHILADELPHIA

The American Society of Naturalists.—December 31. President, Professor Ross G. Harrison, Yale University; secretary, Dr. Bradley M. Davis, University of Pennsylvania, Philadelphia, Pa.

The American Society of Zoologists.—December 30–January 1. *Eastern Branch:* President, Dr. Raymond Pearl, Maine Agricultural Experiment Station; secretary, Dr. Caswell Grave, The Johns Hopkins University, Baltimore, Md. *Central Branch*—December 29–January 1: president, Professor H. B. Ward, University of Nebraska; secretary, Professor W. C. Curtis, University of Missouri, Columbia, Mo.

The American Physiological Society.—December 29–31. President, Dr. S. J. Meltzer, Rockefeller Institute for Medical Research, New York City; secretary, Professor A. J. Carlson, University of Chicago, Chicago, Ill.

The Association of American Anatomists.—December 29–31. President, Professor Ross G. Harrison, Yale University; secretary, Professor G. Carl Huber, 1330 Hill Street, Ann Arbor, Mich.

The American Society of Biological Chemists.—December 29–31. President, Professor A. B. Macallum, University of Toronto; secretary, Professor Philip A. Shaffer, 1806 Locust St., St. Louis, Mo.

The Society for Pharmacology and Experimental Therapeutics.—December 30–31. President, Dr. Torald Sollmann, Western Reserve University Medical School, Cleveland, Ohio; secretary, Dr. John Auer, Rockefeller Institute for Medical Research, New York City.

NEW YORK CITY

The American Mathematical Society.—December 30–31. President, Professor E. B. Van Vleck, Uni-

versity of Wisconsin; secretary, Professor F. N. Cole, 501 West 116th Street, New York City. Chicago, December 26, 27, secretary of Chicago meeting, Professor H. E. Slaught, University of Chicago, Chicago, Ill.

The American Anthropological Association.—December 29–31. President, Professor Roland B. Dixon, Harvard University; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-Lore Society.—December 31. President, John A. Lomax, University of Texas; secretary, Dr. Charles Peabody, 197 Brattle St., Cambridge, Mass.

PRINCETON

The Geological Society of America.—December 30–January 1. President, Professor Eugene A. Smith, University of Alabama; secretary, Dr. Edmund Otis Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—Probably meets at Princeton but official information has not been received.

The Paleontological Society.—December 31–January 1. President, Dr. Charles D. Walcott, Smithsonian Institution; secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

NEW HAVEN

The American Psychological Association.—December 30–January 1. President, Professor Howard C. Warren, Princeton University; secretary, W. Van Dyke Bingham, Dartmouth College, Hanover, N. H.

The American Philosophical Association.—December 29–31. President, Professor E. B. McGilvary, University of Wisconsin; secretary, Professor E. G. Spaulding, Princeton, N. J.

MINNEAPOLIS

The American Economic Association.—December 27–30. President, Professor David Kinley, University of Illinois; secretary, Professor T. N. Carver, Harvard University, Cambridge, Mass.

The American Sociological Society.—December 27–30. President, Professor Albion W. Small, University of Chicago; secretary, Scott E. W. Bedford, University of Chicago, Chicago, Ill.

WASHINGTON, D. C.

The American Association for Labor Legislation.— December 30–31. President, Professor W. W. Willoughby, Princeton University; secretary, Dr. John B. Andrews, 131 East 23d St., New York City.

MONTREAL

The Society of American Bacteriologists.—December 31–January 2. President, Professor C. E. A. Winslow, College of the City of New York; secretary, Dr. A. Parker Hitchens, Glenolden, Pa.

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

THE thirteenth annual meeting of the Botanical Society of Washington was held in the committee room of the Bureau of Plant Industry on October 17, 1913, at 1:30 P.M., with seventeen members present. The customary reports were presented and approved and the following officers elected for the ensuing year: *President*, C. L. Shear; *Vice-president*, A. S. Hitchcock; *Recording Secretary*, C. E. Chambliss; *Corresponding Secretary*, P. L. Ricker; *Treasurer*, H. H. Bartlett. Mr. F. L. Lewton was nominated as Vice-president from the society for the Washington Academy of Sciences.

The ninetieth regular meeting of the Botanical Society of Washington was held in the assembly hall of the Cosmos Club on Monday, October 6, 1913, at 8 P.M., with forty-two members and seventeen guests present, including the following distinguished European botanists: Frau Dr. Brockmann-Jerosch, Zürich; Dr. Edward Rübel, Zürich; Professor Carl Schröter, Zürich; Professor C. von Tubeuf, Münich.

The program consisted of brief informal remarks, as follows:

An address of welcome to the guests of the society, by President Stockberger.

"Citrus Plants of the World and their Importance and Use in Connection with Citrus Cultures and Citrus Breeding," by Mr. Walter T. Swingle.

"A Brief Summary of the Results of Twenty Years' Work with Mistletoe," by Professor C. von Tubeuf.

Professor Carl Schröter of Zürich translated Professor Tubeuf's address into English.

"Plant Introduction Work of the Bureau of Plant Industry," by Mr. David Fairchild.

"Impressions Received during the American International Phytogeographic Excursions," by Professor Carl Schröter.

"Nodule Production and Nitrogen Fixation by Plants other than Leguminosæ," by Dr. Carl Kellerman.

"The Chestnut Blight Disease," by Dr. Haven Metcalf.

"Photographs of Buckthorn Acacias," by Mr. W. E. Safford.

The ninety-first regular meeting of the Botanical Society of Washington was held in the assembly room of the Cosmos Club at 8 o'clock P.M., Tuesday, November 4, 1913, with forty-six members and five guests present.

Dr. Harry B. Humphreys and Messrs. G. C. Husmann and K. J. J. Lotsy were elected to membership.

The action of the retiring executive committee relative to giving a dinner in honor of the seventieth birthday of Dr. Edward L. Greene was called to the attention of the Society by the President, and a committee was appointed to arrange the details.

The following scientific program was presented:

Abbreviations used in the Citation of Botanical Literature: Professor A. S. Hitchcock.

Professor Hitchcock pointed out the different methods used for abbreviating citations, the extreme contraction on the one hand, such as "O B Z" (Oesterreichische Botanische Zeitschrift), and on the other the elaborate citations used by some authors in the *Pflanzenreich*. Abbreviations should be brief as possible consistent with clearness, but should follow a definite system. The speaker described the system followed in abbreviating citations used in the Contributions from the U. S. National Herbarium. The record of authorized abbreviations of authors and titles is indexed in a card catalogue. Authors consult this record when preparing manuscript for publication, thus aiding the editor in securing uniformity.

Non-parasitic Foliage Injury: Mr. Carl P. Hartley.

Notes were given on the effects of drouth and storm on leaves of ornamental trees at Washington, D. C., for the past season. June and July were hot and dry, with but 35 per cent. of normal rainfall. Norway maple, especially in street planting, suffered most from drouth, the margins of leaves being killed; in the worst cases whole leaves except parts immediately adjoining the veins died. Most other trees, including *Acer rubrum*, escaped serious leaf injury. A northeast storm with hail and a 66-mile wind at the end of July injured many species, especially sugar maple and American basswood. The storm injury to maple resulted in the death of large parts of leaves at the margins and between the veins, without laceration or other external indication of mechanical injury. These storm-injured maple leaves could be distinguished from those hurt by drouth only by their limitation to parts of trees especially exposed to the northeast storm.

Pitfalls in Plant Pathology: Dr. H. W. Wollenweber (with lantern).

A revision of the hundreds of species of *Fusarium* in literature has led the writer to believe that the genus *Fusarium* contains only 30 to 50 different forms. To convince himself of this fact he intends to compare his pure culture strains with species of the important exsiccata collections of the old world.

A sharp criticism was given to mycologists who send unreliable specimens to the international "Pilzcentrale" in Amsterdam. Many errors are caused by the earlier opinion that *Fusaria*, as a rule, are adapted to one particular host.[1]

Sections of a Fossil Wood from Asphalt Lake near Los Angeles, Cal. (specimens): Dr. Albert Mann.

Thin sections of the petrified wood were exhibited under a microscope which showed fungus hyphæ. Brief notes were given as to the apparent method of the growth of the fungus and the possible identification of the tree was discussed.

P. L. Ricker,
Corresponding Secretary

THE PHILOSOPHICAL SOCIETY, UNIVERSITY OF VIRGINIA, MATHEMATICAL AND SCIENTIFIC SECTION

The first meeting of the session of 1913–14 of the Mathematical and Scientific Section was held October 20.

The following officers were elected to serve for the session: *Chairman*, Professor W. S. Rodman; *Secretary*, Professor L. G. Hoxton; *Publication Committee*, Professor W. H. Echols, Professor Thos. L. Watson, Professor Wm. A. Kepner.

Professor W. H. Echols read a paper "On the Expansion of a Function in Terms of Rational Functions."

Professor S. A. Mitchell presented a report of work done on an eclipse expedition to Spain.

L. G. Hoxton,
Secretary

University of Virginia

1 Lantern slides were shown to illustrate the difficulties the taxonomist meets, and these were explained and discussed.

SCIENCE

FRIDAY, DECEMBER 26, 1913

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

HENRI POINCARÉ AS A MATHEMATICAL PHYSICIST[1]

WHEN I was asked by the secretary to contribute a paper of general interest before this section I was overwhelmed with the sense of my inability to do so, but when he suggested that I should take as a subject the work of Henri Poincaré as a mathematical physicist, I consented, because, however slight might be my capability, the subject was a most congenial one. The great Frenchman whose untimely death at the age of 58 the whole scientific world deplores was a man of extraordinary versatility, while his productiveness is measured by the fact that the total number of separate contributions from his pen reaches nearly the sum of a thousand. France has always known how to honor her great men, even if she does not understand them, and the impression produced by the death of Poincaré on the whole country was profound. The news was communicated to me in London at the celebration of the Royal Society by his friend and distinguished colleague, Émile Picard, who in a voice choked with emotion pronounced the words, "Poincaré est mort!"

While there can be no doubt that the greatest work of Poincaré consisted in his work in pure analysis, we must not forget that for ten years he filled the chair of mathematical physics of the Faculté des Sciences. During this time he touched every conceivable part of the subject and it may be truly said that he touched nothing that he did not adorn. Fourteen volumes

[1] Read before Section A of the American Association for the Advancement of Science, December 31, 1912.

of published lectures attest his skill as a teacher, the names of which I will not take your time to rehearse, merely remarking that in addition to the usual treatments of electricity, optics, the conduction of heat, thermodynamics, capillarity, elasticity and hydrodynamics there are several volumes on the modern subjects of electrical oscillations and the interrelations of electricity and optics.

The work of the mathematical physicist is of two sorts, according as the emphasis is laid on the word physics or on the word mathematical. In the latter case the investigator concentrates his attention upon the attempt to demonstrate that certain problems have solutions, furnishing so-called existence theorems. In the former the attempt is made to find the solutions, assuming that they exist, in a form suitable for numerical computation. Poincaré did both, and, although capable of the highest flights into abstract mathematics, was by no means insensible to the needs of the practical man, meaning by that not only the physicist, but even the telegraph engineer. This is attested by the number of articles that he wrote on the theory of telegraphy, both with and without wires, as well as by the courses of lectures that he gave at the higher professional school of posts and telegraphs. It is certainly a very rare thing for a pure mathematician of the highest ability to write an article on the theory of the telephone receiver, yet this was done by Poincaré, while in a paper on the propagation of current in the variable period on a line furnished with a receiver he attacked an almost untouched field of very great mathematical importance in the theory of differential equations.

What is particularly striking in all of Poincaré's writings is not so much the clearness of exposition or the elegance of arrangement, for his lectures possess many of the faults of lectures published by students and his short articles are often extremely difficult reading, but rather the remarkable directness with which he proceeds to his results and the extraordinary command of every resource of pure mathematics, particularly of Cauchy's theory of the functions of a complex variable. I know of but one other author whose resources in function-theory seem to be at all comparable with those of Poincaré, I mean Professor Sommerfeld, who seems to be able to communicate his powers in that line to his students. The heart of mathematical physics is, without doubt, composed of partial differential equations, and in this subject Poincaré was, of course, a master. It is in connection with the definite integrals appearing in their solutions that there is great opportunity for the application of function-theory. The great art in mathematical physics is that of making approximations and it is here that Poincaré was particularly strong. It is frequently not so difficult to obtain the solution of the differential equation as to interpret its physical meaning. In this matter Poincaré reminds us of his great countryman Cauchy.

I shall not attempt to make an analysis of the articles of Poincaré, many of which I have great difficulty in following and many of which could be far better treated by others here present. I shall merely undertake to give a slight idea of the contents of those which have particularly impressed me. I presume his contributions of most far-reaching importance from a mathematical point of view are his articles on the equations of mathematical physics, of which he wrote three. This is a subject which has received an enormous amount of attention during the last twenty-five years and it may be undoubtedly said that in

this work Poincaré's contributions were fundamental. His first article "Sur les Equations aux Dérivées Partielles de la Physique Mathématique" appeared in the *American Journal of Mathematics* in 1890. The equations of mathematical physics are all very similar and may be practically all reduced to three or four. Of these the equation of Laplace,

$$\frac{\delta^2 V}{\delta x^2}+\frac{\delta^2 V}{\delta y^2}+\frac{\delta^2 V}{\delta z^2}=\Delta V=0,$$

is the most important. The so-called boundary problem of finding a solution of Laplace's equation, valid for a certain region of space, that shall take prescribed values at the surface bounding this space is known as Dirichlet's problem. Of this the problem of the distribution of electricity on the surface of a conductor is a particular case, the function given on the surface reducing to a constant.

The latter example is a case of the outside problem, where in addition we have the condition that the desired function must vanish at infinity. The demonstration of the existence of such a function given by Riemann and depending upon the application of the calculus of variations to the definite integral

$$\iiint\left[\left(\frac{\delta V}{\delta x}\right)^2+\left(\frac{\delta V}{\delta y}\right)^2+\left(\frac{\delta V}{\delta z}\right)^2\right]dxdydz$$

is lacking in rigor and the attempt to replace it has engaged the attention of some of the greatest mathematicians. In the present paper Poincaré gives a new method of great universality for proving the so-called Dirichlet principle. It depends upon the fact that the boundary problem can be exactly solved for the sphere and also upon the theorem discovered by Green that a potential function due to attracting masses lying within a closed surface may be exactly imitated by placing the masses in a surface distribution on the surface of the sphere. This Poincaré calls the *balayage* of the sphere, the masses being swept out of the interior and deposited on the surface. For any surface to be treated the space within is filled up by an infinite number of spheres such that any point within the given surface lies in at least one of them, and these spheres are swept in a certain order so that the process is a convergent one. The principle of Dirichlet is thus established, but a practical method of finding the solution is not given. The other equation considered in this paper is Fourier's equation for the conduction of heat,

$$\frac{\delta V}{\delta t}=a^2\Delta V.$$

In this case the boundary condition is not as simple as in Dirichlet's problem, but we have at the surface,

$$\frac{\delta V}{\delta n}+hV=0,$$

where h is called the emissivity of the body. In this case it is demonstrated by the aid of the calculus of variations that the problem is possible, the demonstration being that of the existence of an infinite series of functions U_n satisfying the conditions that on the surface of the body

$$\frac{\delta U_n}{\delta n}+hU_n=0$$

and in its interior

$$\Delta U_n+k_n U=0,$$

where the numbers $k_1, k_2 \cdots k_n$ are positive constants such that

$$k_1<k_2<k_3\cdots.$$

Physically these functions have the property that if the temperature of the body at a given instant is distributed according to any one of them then this distribution will remain unchanged during all subsequent time, merely dying away at an exponential rate. It is interesting to notice that in the last part of this paper Poincaré compares his process to that used by

Fourier in deducing his equation; namely, by supposing the body to be composed of a large number of small bodies each radiating heat to all the others according to the law that the amount of heat radiated in a given time is proportional to the difference of temperature of the two bodies. Thus a system of ordinary differential equations is arrived at,

$$\frac{dV_i}{dt} + \sum_{k=1}^{k=n} C_{ik}(V_i - V_k) + C_i V_i = 0, \quad i = 1, 2 \cdots n,$$

which is readily solved by putting

$$V_i = U_i e^{-\lambda t},$$

in which case the differential equations become algebraic linear equations for the quantities U_i,

$$\lambda U_i = \sum_k C_{ik}(U_i - U_k) + C_i U_i.$$

In order to solve them it is necessary that the determinant

$$\Delta = \begin{vmatrix} C_1 - \lambda, & -C_{12}, & -C_{13}, & \cdots \\ -C_{12}, & C_2 - \lambda, & -C_{23}, & \cdots \\ \cdot & \cdot & \cdot & \cdot \end{vmatrix}$$

should vanish. But we get the same equations if we consider the quadratic form

$$\Phi = \Sigma C_{ik}(V_i - V_k)^2 + \Sigma C_i V_i^2,$$

which being equated to a constant represents an ellipsoid in n-dimensional space. The equations for the axes are our linear equations. The axes of this ellipsoid being all real, all the roots of the determinant Δ are real. The form may then be decomposed into a sum of squares.

$$\Phi = \lambda_1\phi_1^2 + \lambda_2\phi_2^2 \cdots, \text{ where}$$
$$\phi_p = U_{p1}U_1 + U_{p2}U_2 \cdots.$$

Upon the properties of this quadratic form depends the whole theory. When the number of particles becomes infinite the system of ordinary differential equations leads in the limit to Fourier's partial differential equation, and the theorems which will arise if the passage to the limit is justified lead to Poincaré's deduction. It is to be noticed that this principle had been used before by Lord Rayleigh in connection with the theory of vibrations, and the possibility of passing to the limit postulated by him is now known as Rayleigh's principle. More interesting still is the fact that to-day this process used by Rayleigh and Poincaré has become in the hands of Fredholm and Hilbert a rigorous method, that of integral equations, which is at present occupying a large part of the attention of the mathematical world.

In his second paper on the same subject published in 1894 in the *Rendiconti del Circolo Mathematico di Palermo*, Poincaré passes to the consideration of the more general equation

$$\Delta u + \xi u + f = 0,$$

where ξ is a constant and f a given space-function. This equation includes not only Fourier's equation but the equation of waves

$$\frac{\partial^2\phi}{\partial t^2} = a^2\Delta\phi + g$$

if we put

$$\phi = e^{int}u, \quad \xi = \frac{n^2}{a^2}.$$

Regions in which f is not zero are called sources of heat or sound. Poincaré proceeds in this equation to develop u according to powers of ξ, as had been done by Schwarz, thus obtaining a solution by successive approximations which he proves to be convergent. He also proves the fundamental property that a solution of the equation is a meromorphic function of the parameter ξ having an infinite number of simple poles, that is to say,

$$U = \Sigma \frac{\alpha_i U_i}{\xi - k_i} \quad \text{where} \quad \Delta U_i + k_i U_i = 0.$$

This theorem is also fundamental in the theory of integral equations. To speak in the language of sound Poincaré demonstrates the existence of an infinite number of natural vibrations for the air in a cavity surrounded by the given surface, the characteristic numbers k_i or values of the poles

of the solution giving us their periods, and the nature of the function U showing the phenomenon of resonance, that is to say, the vibration becoming infinite when the impressed force has the period of one of the natural vibrations. The method of Poincaré leads directly to Schmidt's solution of the integral equation.

In a third paper published in the *Acta Mathematica* in 1897 Poincaré deals with what he calls Neumann's problem, which he defines as follows: To find a potential of a double layer whose limiting values inside and outside the surface are denoted by V and V', and which satisfies the equation at the surface,

$$V - V' = \lambda(V + V') + 2\Phi,$$

where λ is a parameter. If $\lambda = -1$ this reduces to the interior Dirichlet's problem $V = \Phi$ and if $\lambda = 1$ to the exterior problem $V' = -\Phi$. By means of a development in powers of the parameter λ a solution is obtained by successive approximations which is proved to converge. One of the most important results of this paper is the demonstration of the existence of a series of what he calls fundamental functions which have the property of being potentials of simple layers, and

$$\frac{\delta \Phi_i}{\delta u} = -\lambda_i \frac{\delta \Phi'}{\delta n}$$

in terms of which he deems it probable that any function on the surface may be developed, so that when these functions are known Dirichlet's problem may be solved. These reduce for the sphere to spherical harmonics and for the ellipsoid to Lamé's functions, and they are the characteristic functions belonging to integral equations.

Let us now turn to a different field. In 1893 attention was called by Poincaré to an equation which has become famous, called by him the equation of telegraphists. This equation

$$a\frac{\delta^2 u}{\delta t^2} + 2b\frac{\delta u}{\delta t} + cu = \frac{\delta^2 u}{\delta n^2}$$

had been introduced before by Kirchhoff and Heaviside, but its physical interpretation had not been emphasized. If the first term is lacking it reduces to Fourier's equation and it had been shown by Sir William Thomson in 1855 that signals were propagated through a submarine cable in accordance with it. If the second and third terms are absent the equation reduces to the equation of sound in one dimension and shows the propagation of waves unchanged in form with a constant velocity. The equation of telegraphists may then be expected to combine the properties of transmission in waves and heat transmission with an infinite velocity. The first term arises from the consideration of the self-induction of the line neglected by Thomson and the second term from the resistance which can generally not be neglected. By the simple method of the assumption that u can be represented as a Fourier's integral, after taking out an exponential factor, so that

$$\frac{\delta^2 U}{\delta t^2} = \frac{\delta^2 U}{\delta x^2} + U, \quad U = \int_{-\infty}^{\infty} \theta(q) e^{iqx} dq,$$

Poincaré obtains the solution

$$U = \int_{-\infty}^{\infty} e^{iqx}\left[\theta \cos t\sqrt{q^2 - 1} + \theta_1 \frac{\sin t\sqrt{q^2 - 1}}{\sqrt{q^2 - 1}}\right] dq,$$

which he shows by an application of the theory of functions to depend upon a Bessel function. The remarkable physical result is that while the disturbance, like the sound wave, is propagated with a finite velocity, after it has passed over a given point it leaves a residue or trail which gradually dies away like heat. In a later paper he discussed the effect on the telegraphist's equation of terminal conditions of a complicated sort necessitated by the employment of receiving apparatus.

Probably the favorite subject in mathe-

matical physics treated by Poincaré was that of electrical waves and oscillations. The reason for this is not far to seek. Not only are the equations of Maxwell's theory, complicated though they seem to be and involving a large number of vectors, capable of reduction to one of the forms already mentioned, but their solution calls for great knowledge of differential equations and even in the last few years in the hands of Poincaré permits of being treated by integral equations. Besides this the applications to the subject of wireless telegraphy are of great practical importance as well as theoretical interest. If we write Maxwell's equations in the simplest case,

$$\alpha = \frac{\delta H}{\delta y} - \frac{\delta G}{\delta z},$$

$$\cdots\cdots\cdots \qquad \frac{\delta f}{\delta x} + \frac{\delta g}{\delta y} + \frac{\delta k}{\delta z} = \rho,$$

$$4\pi f = -\frac{\delta F}{\delta t} - \frac{\delta \psi}{\delta n},$$

$$\cdots\cdots\cdots \qquad \frac{\delta \alpha}{\delta x} + \frac{\delta \beta}{\delta y} + \frac{\delta \gamma}{\delta z} = 0,$$

$$4\pi\left(u + \frac{\delta f}{\delta t}\right) = \frac{\delta \gamma}{\delta y} - \frac{\delta \beta}{\delta z},$$

$$\cdots\cdots\cdots$$

where (α, β, γ) denotes the magnetic field, 4π $(f, g, h,)$ the electric field, u, v, w the conduction current, ρ the electric density, Ψ the electric scalar potential, (F, G, H) the vector-potential, where the vector-potential is defined by the differential equations

$$\alpha = \frac{\delta H}{\delta y} - \frac{\delta G}{\delta z}, \quad \cdots$$

there is still something indeterminate in this vector. Maxwell assumes

$$\frac{\delta F}{\delta x} + \frac{\delta G}{\delta y} + \frac{\delta H}{\delta z} = 0,$$

which does not lend itself to simplicity, but if instead we put, as was later done by Lorentz,

$$\frac{\delta F}{\delta x} + \frac{\delta G}{\delta y} + \frac{\delta H}{\delta z} + \frac{\delta \psi}{\delta t} = 0,$$

we get a great simplification. It is notable that this was done by Poincaré in 1893 in his lectures on electrical oscillations, evidently quite independently of Lorentz. Our equation for the vector-potential then reduces to the form

$$\frac{\delta^2 F}{\delta t^2} - \Delta F = 4\pi u,$$

which shows that if there is no current anywhere the vector-potential is propagated in waves. The scalar potential also satisfies the equation

$$\frac{\delta^2 \psi}{\delta t^2} - \Delta \psi = 4\pi \rho.$$

It was shown by Lorentz in 1892 and independently in the same year by Beltrami, that this equation, which, in case the first term vanishes, reduces to that of Poisson, is satisfied by a potential function

$$\psi = \iiint \frac{\rho' d\tau}{r},$$

in which, however, ρ' represents the value of ρ not at the instant in question but at an instant precedent by the time required to come from the point of integration with the wave-velocity. Such a potential is now known as a retarded potential and I may be allowed for a moment to digress upon the interesting history of this Lorentz-Beltrami equation. Its properties with those of the retarded potential are given by Poincaré in his lectures in 1893, evidently quite independently of Lorentz. It turns out, however, that the properties of the equation are given in Lord Rayleigh's "Theory of Sound," appearing in 1877. This, however, is not its first appearance, for we find the same equation in a paper by L. Lorenz, of Copenhagen, in 1869, on elasticity. More remarkable yet in a paper presented by Riemann to the Royal Society of Göttingen in 1858, but published only in 1867 after Riemann's death, we find the same identical equation for the electric potential although deduced from considerations which are now untenable. It is curious to remark that although this equation is mentioned by Maxwell in the last chapter

of his great work he does not commit himself as to its conclusions, but states that Clausius has shown that the hypothesis that the potential is propagated like light does not lead to the known laws of electrodynamics. Curiously enough, to-day this is exactly what we do believe, and it is interesting to know that such a result was vainly sought for by Gauss.

It is easy to conceive, the equations of electrical propagation being so similar to those of the propagation of sound waves, how the question of fundamental functions arises in connection with electrical oscillations emitted by a conductor of given form. The only case of anything except a linear conductor that has been completely treated is that of a sphere and of this a treatment was given in the same lectures in 1893 by Poincaré. One of the most important questions in wireless telegraphy has been during the last ten years and still is the explanation of the possibility of sending Hertzian waves across the Atlantic, a distance of perhaps one tenth of the way around the earth. The question of diffraction has always been an attractive one and in the case of electric waves makes great demands upon the powers of the mathematician. After a number of articles on the subject Poincaré in 1909 applies to it the method of integral equations, which he continues in a lecture on the Wolfskehl foundation at Göttingen, and later in a tremendous paper in the *Palermo Rendiconti*.

The development of Maxwell's electromagnetic theory that has taken place in the last twenty-five years has led to a theory that has attracted the greatest interest among mathematical physicists and has, in fact, become in certain parts of the world no less than a mania. I refer to the so-called principle of relativity, a name which was given to it first, if I am not mistaken, by Poincaré. This principle is no less than a fundamental relation between time and space, intended to explain the impossibility of determining experimentally whether a system, say the earth, is in motion or not. In an elaborate paper published in 1905 in the *Palermo Rendiconti* entitled, "Sur la dynamique de l'électron," he defines the principle of relativity by means of what he calls the Lorentz transformation. If the coordinates and the time receive the following linear transformation,

$$x' = kl(x + \epsilon t), \quad t' = kl(t + \epsilon x), \quad y' = ly,$$
$$z' = lz, \quad k = \frac{1}{\sqrt{1 - \epsilon^2}},$$

the function $x^2 + y^2 + z^2 - t_1^2$ and the equations of electric propagation will remain invariant. From this follows the impossibility of determining absolute motion. Poincaré then submits the Lorentz transformation, which he shows belongs to a group, to an examination with regard to the principle of least action, which he shows holds for the principle of relativity. He further shows that by the aid of certain hypotheses gravitation can be accounted for and shown to be propagated with the velocity of light. This is a subject which is now very much in the air, but it must be said that various writers arrive at conflicting results.

From what I have said, it will have been seen that Poincaré was exceedingly up-to-date and at once made the newest speculations and theories his own. As the final example of this may be named a theory which has created nearly as great a shock as that of relativity. I mean the theory of light *quanta* introduced by Planck to account for the laws of radiation from a hot body. In order to apply the laws of probability to electric resonators Planck had felt obliged to introduce the hypothesis that energy is emitted by resonators not in continuous amounts but in amounts depending upon certain multiples of a definite quantity

known as the quantum. In one of his very last papers published in January, 1912, in the *Journal de Physique,* Poincaré submits the theory of quanta to a searching examination and as a conclusion announces that it is impossible to arrive at Planck's law except under the assumption that resonators can acquire or lose energy only in discontinuous amounts. If this is true we have an extraordinary departure from received ideas and it will be necessary to suppose that natural phenomena do not obey differential equations.

Enough has been said to show the extraordinary variety of the subjects treated by this commanding intellect in the subject of mathematical physics alone. In repeating what I stated at the outset that the striking quality displayed by Poincaré is his extraordinary skill in analysis, I do not mean for a moment to imply anything against his intense receptivity for all physical ideas, for which he had a very great penetration. It is true that he sometimes met severe criticism from physicists. In particular Professor Tait made a bitter attack on his treatise on thermodynamics, but in my opinion Poincaré was well able to defend himself. It has sometimes been doubted whether he thoroughly appreciated Maxwell's ideas as to the theory of electricity, but this is of small moment, seeing that he so well understood their consequences. It must be said that Poincaré was not one who contributed fundamental new ideas to our stock of physical conceptions, such as the ideas put forth by Carnot, Kelvin, Maxwell, Lorentz with his principle of local time or Planck with his quanta.

I may in conclusion be permitted to state my opinion that the best persons to appoint to chairs of mathematical physics and those most likely to enrich our conceptions are those who have themselves had experience in dealing with nature with their own hands in the laboratory, and who may be expected to have more feeling for her modes of action than skill in analysis. Thus I believe Helmholtz, Kelvin, Maxwell, and Lord Rayleigh to have been more important contributors to mathematical physics than Poincaré, but this is not to say that the latter was not an intellect of superlative greatness.

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UNIVERSITY ORGANIZATION[1]

This subject has become in recent years one of intense interest. In most utterances on the subject the prominent feature is the statement that our universities are undemocratic, that they are monarchical institutions in a democratic country. This criticism takes various forms. When a university president speaks, the shortcomings of the university are due to the fact that the governing board are ignorant, shallow-minded, arrogant and headstrong; that they insist upon deciding matters beyond their knowledge and will not be guided by the president. When a university professor speaks it is the university presidency which is at fault. Autocracy, blindness, willfulness, prejudice, partiality, lofty-mindedness, oratorical ability, money-getting talents, piety and many other virtues and vices are ascribed to our presidents, but in the minds of nearly all writers the presidency is an unsatisfactory tool. When an outsider speaks, both president and governing board are parts of a vicious organization.

Let us grant that there is much truth in this. Boards may be unwise; the presidency may be unequal to its responsibili-

[1] With especial reference to state universities. An address delivered before a body of university men at Minneapolis, November 10, 1913.

ties and opportunities. Yet there is a third point of view, a more fundamental consideration. In the American university, as in the Russian political system, the chief difficulty is not with the autocrat, but with the bureaucrat. In my opinion, we can not go much farther astray than baldly to lay the shortcomings of our universities upon the president. As for the presidency, it is part of a great system; the president is the unfortunate occupant of an office.

Let us see how the matter stands. Any large institution such as one of our universities, in order to be successful, must have general aims or policies, must have an organization to carry them out, and must secure at once the successful operation of each of its subdivisions in its own sphere and the cooperation of each of these in the larger ends of the whole. The president is given, nominally at least, the responsibility of directing this organization in general and the right, when necessity arises, to intervene in the conduct of any of the parts in order to make them efficient and to adjust their relations with the remainder of the institution. Can any president do this under present conditions?

To bring about efficient work for desirable ends in any large institution certain things are necessary. First, a knowledge of what are the desirable aims or ideals for that institution and of how these ideals should be adjusted to the conditions of human life and to the life of the particular community from time to time. Second, a knowledge on the part of the executive of the workings of all parts of the institution and of the abilities of each member of the staff. Third, the possession of actual power by the executive to secure the cooperation of all parts in whatever is for the common welfare. This is true no matter whether the common welfare is found in the closest centralization or in the greatest freedom of individual action, no matter whether the executive is a president or a committee or takes some other form. Our universities must be organized, must have common ends and must exercise executive power, if the only end of that power be to secure anarchy. It is my purpose to inquire what is wrong with the present organization, that our universities should work so badly and that individuals should suffer so in the process.

Where does a university get its ideals or policies? Necessarily, they become the possession of the institution through the expression of ideas or opinions by members of the faculty and student body and through the accumulation of such ideas in the form known as traditions. Individuals in the university, whether president, instructors or students, necessarily furnish the ideas out of which common aims are constructed and in accordance with which old aims are adjusted to new conditions. Is there at the present time any adequate means by which the ideas of individuals can be made available for the common good? Two illustrations will answer the question in part. The head of a university department called together his entire staff including student assistants to discuss the organization of teaching with a view to improving the arrangement and content of the courses of study. The whole matter was discussed at two successive meetings, the professors talking over various plans without coming to any satisfactory conclusion. Instructors and assistants had been asked to think over the matter and at the second meeting each one in turn was called upon for suggestions. One assistant had a plan entirely different from anything that had been suggested. He outlined it and showed how it would improve the teaching and bring about a better correlation in

the work of the department. The men of professorial rank criticized the plan severely and the young man was made to feel that he was presumptuous in proportion as his plan was chimerical. After a rather long interval a third meeting was called. The head of the department announced that a plan had been devised, and proceeded to outline the identical plan which had been proposed by the assistant. It remained in effect for several years. Absolutely no hint of credit or recognition was ever given to the young man. Again, an instructor arose in general faculty meeting in an arts college in a state university and discussed a pending question at some length and with much coggency. His friends were filled with apprehension and one of them finally succeeded in signalling to the speaker to desist. He was afterwards informed by the dean that men below the rank of assistant professor were not expected to debate questions in the faculty. Instances might be multiplied to show that great difficulties stand in the way of the ideas of young men finding expression or receiving consideration in our universities. It is a well-known fact that in many departments the young men never know what plans are afoot until their duties are assigned them. And yet the young men are the only ones who can offer any new ideas to their institutions. Let it not be thought that the writer has any personal interest in this aspect of the question. He has passed the time when he can expect to produce any *new* ideas. Whatever new ideas he might have contributed to the universities with which he has been connected are lost forever,—unless indeed, ear is still given to what he might have said years ago. Of course, that is precisely what our mode of organization means. The university forbids a young man to speak until he becomes a professor. Then if he has not forgotten the ideas which came to him in the days of his youth and enthusiasm, or if the time for their application has not long gone by, the institution is willing to listen to him. That ensures conservatism,—but not progress. It means that the university never adjusts its ideals to the times but is forever denying itself the information which its individual members could supply.

If the university is slow and inefficient in securing information as to what should be its aims and policies, what about the sources of information for the executive as to how those policies are being carried out? The president depends for his information first upon the deans of colleges and schools, and second, upon the heads of departments. He depends upon these men also for executive functions under his direction. The president must depend upon these men for information, since he can not by any possibility know all the details by his own observation. Neither can he go personally to all individuals for information. In general the president is equally under the necessity of following the advice of his heads of departments, since otherwise he would lose their confidence and his only source of information. The president instead of being the autocratic monster that he is depicted, is in an almost pitiable situation. Unless he be a man of altogether extraordinary energy and strength of purpose, he is wholly at the mercy of his heads of departments. So far as the heads of departments are honest, wise and possessed of ideals for the common good the president is fortunate, and nothing that I may say in this talk can be construed as a criticism of such men. But heads of departments are endowed with human nature, and it is well known that they exhibit it in the conduct of their departments.

In one case a department of chemistry

was equipped with a great amount of expensive glassware and analytical apparatus of which the head of the department did not know the uses, while the students' tables were almost devoid of ordinary reagent bottles. The younger men in the department were unable for a long time to secure the ordinary equipment needed. In other cases men who were drawing full professors' salaries have taken their time for outside professional work or for dealing in real estate, coal or gas, neglecting their teaching and imposing extra work on the instructors to the detriment of both instructors and students. A head of department may carry on for years policies which are not approved by a single member of his staff; may absent himself from all teaching whatever; may neglect to do any research work or contribute anything to the advancement of his science; may pursue constantly a policy of selfish material aggrandizement for which the department suffers both in the esteem of the university and in the decrease of scientific work which the members of staff can do; may deliberately sacrifice the interests of the students to his personal ambitions, and may in these ways cause constant friction and great waste of energy throughout the college—all this while maintaining a pretense, or even a belief, that he is a most public-spirited and useful member of the faculty. The head may conduct his department in such a way as to make research impossible and even drive men out of his department because they do research, all the while that he himself talks of the importance of research. Heads may appoint to high positions men who have given no evidence whatever of their qualifications for the work proposed. Heads of departments and deans have been known to use their offices to secure advancement for their personal friends and are able to side-track valuable proposals for the common good which threaten to compete with their own interests.

The head of a department enjoys a remarkable liberty in the conduct of his department and in the performance of his individual duties. He may suppress the individualism of his staff members, ignore any suggestions which they may make, and dismiss them if they insist upon their ideas. He may falsify the reports as to the teaching and other work done by himself and by members of his staff. If subordinate members of the staff have different ideas as to the conduct of the departments they are vigorously overruled by the head, and if any question of bad policy or of injustice is brought to the stage of investigation by the president, that officer is governed by the principle that all matters of testimony must be construed by him in a light as favorable as possible to the head of the department. The president is bound to do this because he is dependent upon his heads of departments for information, advice and executive assistance. The "heads of departments" thus become a *system* which involves the president and from the toils of which he can not easily extricate himself. It is a matter of common knowledge that in some departments no member of staff is asked for his opinions or is encouraged to hold or express independent views, that younger members of the faculty commonly dare not express themselves publicly or go to the president or dean in matters in which they differ from the heads of their departments, and that generally the department head assumes that the decision of any question resides with the "responsible head," regardless of the views of his subordinates. There is no way in which the members of staff can influence the policy of their department, there is no chan-

nel by which the facts can be brought effectively to the notice of the president or governing board, and there is no assurance in our present form of organization that the welfare of the staff or their opinions as to the welfare of the university, would receive consideration if opposed to the desires of the department head. All this is expressed in common university parlance by saying that the head regards the department as his personal property and the members of staff as his hired men.

I believe that a truer statement of the case is this. Some years ago each subject was taught by a single professor. The growth in the number of students made it necessary to appoint new instructors to assist the professor. At first these assistants were very subordinate in years and experience and it was only natural that the responsibility for the work of the department should remain with the professor. With further growth of the institution the department staff has come to include several instructors and professors, each of whom has a primary interest and responsibility in the welfare of the department and of the institution. Instead of this being recognized, the full powers of the department have been left in the hands of the original head. These heads have in consequence come into control of the sources of information to the executive, have jealously guarded their great powers, and are able to direct departmental and university policies through holding the president in ignorance and their subordinates in contempt. In other words, university control has come to be vested in a system of *ir*responsible heads of departments. This was what was meant in the beginning by saying that the difficulty lies not with the autocrat, but with the bureaucrat. More than one well-meaning university president has recognized the situation, admitted his powerlessness at critical periods and has sought to extricate himself and his university by having recourse to private interviews and by the appointment of advisory committees.

If the only evils of this system were that it entails upon the president great difficulties of university management and results in the misdirection of department affairs and the waste of material resources, it would not be so intolerable. Its more serious effects are that it lowers the efficiency and the moral and spiritual tone of the whole institution, that it wastes the time and energy of whole staffs in order that the head may take his ease or satisfy his ambitions. Moreover, taking away from faculty members the responsibility for the conception and execution of university policies is the best possible way to break down the practical efficiency of these men and to reduce the college professor by a process of natural selection to the impractical, inexperienced hireling that he is popularly supposed to be. Whether this is in part the cause of the wretched teaching which is done in our universities and of the lack of standards of work and of character for the student, I leave you to judge.

There is a second unfortunate feature in our university organization to which I will give only brief attention. This is the prominence of the colleges and schools and the sharp boundaries between them. The colleges are not based upon any natural subdivision of knowledge, but upon practical or technical grounds. Each college has in view the esteem of its own profession and has little sympathy with other colleges which make up the university. The very existence of the colleges creates special interests and produces strife which is in no way related to the welfare of the student or the general public. Teaching

and equipment—apparatus, supplies, library—are duplicated, the natural relations of fields of knowledge are subordinated to the practical application of specific facts and laws, college walls and college interests intervene to prevent the student from following co-related subjects in which he is interested, professional interests and professional ideals begin early to narrow the student's vision and to substitute professional tradition and practise for sound judgment and an open mind. All this is unfortunate. The professions should foster but not confine their apprentices. A student preparing for professional work should have the advantage of the traditions and practises prevailing in the profession, but those traditions and practices should not constitute limitations on his opportunities, his enterprise or his initiative.

A third evil tendency in our universities is the growing complexity of administrative organization. Good results can not be secured by relying chiefly on a system of checks and safeguards. These can not replace capability, honesty and a genuine interest in the university's welfare. Checks and safeguards can at best only prevent some abuses, while they certainly place obstacles in the way of men who would do honest work. It is of doubtful value to set a sheep dog to keep cats from killing young chickens—especially when the main business of the university is not to raise either sheep or chickens but to rear *men*. There is a constant danger that good men will be obliged to kotow to administrative officials who ought to be servants but who proclaim themselves masters. To appoint capable men and to place confidence in their concordant judgment would at once prevent the abuses and secure the desirable ends.

FUNDAMENTAL PRINCIPLES UPON WHICH UNIVERSITY ORGANIZATION SHOULD REST

The functions of a university are three. First, to bring together teachers and students under such conditions that the whole field of knowledge is opened to the student and he is offered competent and reliable advice and assistance in his studies. The second function arises from the responsibility for the competent direction of the student's work. The university must examine the foundations of its authority by making original investigations to test, correct and enlarge the existing body of knowledge. No institution which neglects to prosecute research in as many fields as practical conditions permit, is worthy of the name of university. The third function of a university is to make its store of knowledge practically available to its community and patrons and to stimulate in the members of the community an interest in the further acquisition of knowledge.

The university is thus concerned with knowledge and its applications. University organization exists for the purpose of securing suitable conditions for research and teaching, for the acquisition and the application of knowledge. Certain of the conditions of successful work in a university may be laid down without argument. First, that each individual instructor or student should enjoy freedom and bear responsibility in his work, *i. e.*, he should be judged by his achievements. Second, the recognition of the facts that dealing with knowledge is the central function of the university; that all organization must contribute to this end; that the teacher, the student and the research worker are the sole persons of primary value in the university; that all administrative officers are accessory machinery; that all organization should spring from those primarily engaged in the

university's work; and that all authority should rest with these and with the community which supports the institution. This organic relation of the actual workers to the university government is at once a natural right and the foundation of that personal interest and enthusiasm which are necessary to successful endeavor. Note that I do not say that the instructor and research worker should be *made to feel* that he has an interest in the university organization and a part in university policies through his advice and so forth, but that the teacher and research worker is in the nature of things the actual source of authority in the university, conditioned only by the relations of the university to its community.

What, now, is the proper form of university organization, and how can it be approached in our state universities?

The governing board should represent both the community served and the university. The people of the state furnish the financial and spiritual support for the university and receive the benefits of its work. The support can be withheld whenever the returns are unsatisfactory. The interests of the people do not require to be protected by the governing board. The members of the university faculties contribute their lives, and receive in return a living wage. It is only with the greatest difficulty that they can withdraw their investment in the enterprise. They furnish also the plans of work and the expert direction. The nature of the work is such that it is essential that the staff should have a free hand in executing its plans and should be responsible to the people for its achievements. It seems clear that a governing board composed of three members appointed by the governor from the state at large, three members elected by university faculties from their own number, and the president, would at least not err on the side of giving too great autonomy to the university. It is clear that complete autonomy would carry with it the danger of losing touch with the university's constituency, while the presence of an equal representation from the university and the state would free the faculty permanently from the stigma of control by "non-scholar trustees." Those present well know, however, that boards of the existing type may show an excellent spirit and judgment.

The internal organization of the university should have reference solely to efficiency in teaching and research. The organization should be created by the members of the staff by virtue of their sovereign powers within the institution. The first natural subdivision of the university is that into departments based upon the relations of the fields of knowledge. The process of subdivision of subjects and creation of new departments has gone too far and must be reversed. Under the old order of things the only way for a man of parts to gain recognition and influence which he was capable of using, was to become the head of a department or the dean of a college. This accounts for the creation of many new departments and schools for which there was no need. Administration could be simplified, duplication of work, apparatus, books and supplies could be avoided, and a closer correlation and a better spirit and more stimulus to scholarly work could be secured by the creation of larger departments based on close relationship of subject-matter.

The staff of such large departments might number ten, twenty or more men. In the nature of things the organization within such a department is based upon the personal interest of each member of the staff in the success and welfare of the department, and its object should be to place the resources of the department in

the fullest degree at the command of the student and to facilitate research. These things can be secured only where there is harmony among the staff and where the ideas of the staff are carried out in the administration of the department. Harmony of ideals and executive representation can be secured only by the *election* both of new members of the staff and of the administrative head of the department. New members of staff should be nominated to the president by those who will be their colleagues and who are best able to judge of their fitness for their places. The president will of course actively share the responsibility of appointments. Promotions should be recommended by the chairman and approved by a university committee on promotions.

All important business should be done in staff meetings. The chairman should administer department affairs according to the decisions and by the authority of the staff and should *represent* the staff in relations with other departments. Within the department there should be the greatest practicable freedom of the individual in teaching and research, together with publicity of results. Subdivision of the field covered by the department, organization and assignment of work would be done in staff conference. Publicity regarding the number of elective students, percentage of students passed and failed, average grades given, research work accomplished, and so forth, would furnish opportunity for comparison, friendly rivalry, self-criticism and improvement of the work of each teacher. The first step toward improvement of organization of state universities would be the organization of department staffs to bear the responsibilities and to direct the work of the department through an elected chairman. The second step would be the gradual combination of smaller into larger departments.

The next important step would be the breaking down of the boundaries between colleges on the side of teaching and investigation, making each student perfectly free to study where and what he will, subject only to the regulations of departments and to the means of gaining his own ends. Some present schools and colleges would take again their proper places as departments, the others would be dissolved.

So far as the present colleges serve a useful purpose their place would be taken by faculties for the supervision of professional and degree courses. Each such faculty should be made up of representatives of all departments which may offer work toward the given degree, such representatives to act under instructions from the staffs of their respective departments. These faculties should prescribe requirements for entrance and for graduation but should have no control of finances or of appointments. They should exercise only an advisory function in regard to the election of studies or the student's use of his time. Any faculty might, if it was deemed advisable, prescribe final examinations over the whole course of study, or the presentation of a thesis, and so forth. Thus we should have an A.B. faculty, an LL.B. faculty, an M.D. faculty, and so on, each safeguarding the traditions which surround its degree or the standards which should be upheld in the profession, but each giving full opportunity to the various departments to place before the student new materials, methods and ideals; and giving to the student opportunity to try his powers and extend his acquaintance beyond the usual limits laid down by the traditions of his degree or his chosen profession. This mode of organization would also make it as easy as possible for the student to change his course in case

he found that his choice of a profession was unsuited to his individual talents.

In such an organization the university senate might have somewhat enlarged powers and more detailed duties. The administrative functions now exercised by the faculties and deans of colleges would in part vanish, in larger part be transferred to the several departmental staffs and in part devolve upon the senate either in the first instance or through reference from departments. The senate would continue to be a court of appeal in cases of dispute between faculties or departments. The establishment of new degrees or degree-courses would require action of the senate, and sweeping changes in any curriculum or the membership of any faculty should have the approval of the senate. For example, the university could not establish a new school of naval architecture or of mental healing or of colonial administration each leading to its special degree, without the sanction of a body representing the whole university. Neither could the faculty of arts radically change the character of the course leading to the A.B. degree, either by the ingestion or the extrusion of a large group of departments, without such action being subject to review by the university senate. More need not be said on this phase of the subject. It seems clear that with the greater freedom of action on the part of students and departments, with special faculties laying down regulations for the various degree-courses, with the elimination of rivalries and strife growing directly out of the organization by colleges, the problems of internal correlation and control would be greatly simplified and could readily be cared for in a senate organized very much as ours is at present.

Simplification in university work and administration is the crying need next to independence and responsibility of the members of the faculty. The endless red tape of business administration could be largely done away with by the logical completion of the budget system. The budget having been made by the governing board, each department should be perfectly free to expend its own quota of funds by vote of its staff without supervision or approval of anybody—and should be held responsible for the results secured from year to year. Nobody can know so well how money should be expended as the staff who are to use the things purchased, no one knows so well where to get things or how to get them promptly when needed, none feels so directly and keenly the effects of misuse of money, none will so carefully guard its resources as the department itself. The dangers of duplication will be set aside by the better correlation of departments already suggested. In establishing common storerooms, purchasing agents and the like, the first and chief step should be to ask of the members of the staff throughout the university, how can the administration help you in your work through such agencies as these, instead of thinking how these agencies can remove from the departments the ultimate control of their work. Time and money may be wasted at a frightful rate through fear to place responsibility and confidence where they belong—a fear which is well-founded on our present system of irresponsible heads of departments.

Simplification in the administration of teaching would be favored by the dissolution of the colleges and the setting free of the elective system under a few simple regulations as to the combination of elementary and advanced courses and of major and cognate work which would be necessary for an academic degree, and as to the prescribed curriculum in a professional course. What is needed is fewer regulations and

better teaching; fewer snap courses, fewer substitutions and special dispensations; less care for the poor student and more food for the good student; less interest in sending forth graduates and more measuring up of students against standards of honesty, industry and self-judgment.

Finally, the presidency. Shall the president be elected by the faculty? Shall his actions be subject to review by the senate? Shall he have a veto power over the senate? Shall his duties be limited to those of a gentleman, orator and representative of university culture, or to those of the business agent and manager? The discussion of these questions seems to the writer to be of minor importance. With such a governing board and such an internal organization as has been briefly outlined, it can scarcely be doubted that the president will be representative of his faculty or that he could secure intelligent action from the board. Nor would it be difficult for the president to be a leader in whatever ways he was fitted for leadership or in whatever matters leadership was required. It seems to me that the presidency should be controlled by unwritten rather than by written laws. What is essential is that the university have a strong executive; strong in the discovery and application of right principles, strong in his reliance upon the consent and the support of the governed and strong in the execution of their ideals. The remedy for our evils is not to object to a strong executive, but to remove the necessity for an arbitrary executive; not to cry out for anarchy, but to introduce self-government.

Allow me to recapitulate. Our universities are laboring under a bureaucratic form of government in which the initiative rests chiefly with the heads of departments, in which there is a constant struggle for power among the bureau heads, in which these same heads are the chief source of information and advice to the executive, in which most of the faculty have no voice in framing policies, and in which—at its worst—the student is concerned only to be counted and the public only to be milked. The extreme of degradation is reached when research is wholly neglected and teaching is regarded as only the excuse for material aggrandizement. The bad state of affairs which we see every now and then in this or that department or college in all our universities can not be regarded as the free choice of any average group of men. I can not conceive of any of these things being voted by members of a staff. These conditions are the result of the arbitrary power placed in the hands of single men without check or publicity. Such a system always breeds dishonesty and crime. The remedy is to recognize the primary interest of every member of the staff and to establish representative government in the university. On the whole and in the long run the combined judgment of the members of the staff of any department is sure to be better than that of any individual. Self-government stimulates individual initiative and calls forth ideas for the common good. The enjoyment of freedom and responsibility will make of our faculty morally strong and practically efficient men, and will call into the profession capable men, men robust in intellect and imagination, instead of the weaklings who now barter their souls for shelter from the perils of a competitive business world.

It may be true in a legal sense that the state through the board of regents now hires the members of the university faculty. But men to do university work *can not be hired.* Those of the faculties who now do university work do it not because they are paid living wages, but because they love the work. It has been one of the great fallacies of human history to suppose that workmen

can be hired. When you hire or enslave a man you secure only mechanical service. The world's work can not be done by hired muscle alone, but requires personal interest, moral character and entire manhood. Slaves survive in their pyramids, their temples and their papyri, where their masters have perished. The successful and progressive civilizations of to-day are founded on the freedom and self-satisfaction of the individual. The most acute problems of modern society arise out of the hiring of men to do work which they would much prefer to do for themselves and would do better for themselves. These things bear their lessons for universities, if we will heed them. Freedom of speech and complete self-government are necessary to the best interests of a university. A whole staff is together more capable than any one man. Suppression of staff members who speak without authority of the head is the suppression of truth and initiative. It has resulted and must result in the selection of weak men for the faculty and in narrowness, bigotry and provincialism in the institution. Self-government will draw strong men into the faculty, will stimulate initiative, will make possible and encourage progressive administration, and will bring to mental endeavor on the part of both student and teacher the freshness of the morning air, the pursuit of a goal of one's own choosing, and satisfaction in the achievement of one's ideals.

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THE FUR-SEAL CENSUS FOR 1913

IN the summer of 1912, for the first time, a complete enumeration of the breeding stock of the fur-seal herd of the Pribilof Islands was made. Prior to that season estimates of the herd were based upon a full count of harems, to which an average harem, obtained by counting individual animals upon a part of the breeding ground, was applied. The rookeries counted were naturally the smaller and more scattered ones and the average harem derived from them did not fairly represent the larger rookeries. The importance of the annual estimates, however, lay in the measure of decline which they afforded, and for this purpose they were as useful as exact counts would have been.

The treaty of July 7, 1911, suspended pelagic sealing, the cause of the herd's decline, and it was natural to expect a cessation of decline and the beginning of growth toward recovery. The exact condition of the breeding stock at its lowest point became, therefore, in 1912, a consideration of the greatest importance. A count of all the breeding families, which was in effect a count of the breeding males, was easily made, but the females come and go in the sea and are never all on the land at one time. They furthermore could not be counted accurately, if they were all present, as they can not be herded or driven. Their direct enumeration, therefore, is an impracticable thing. The young pups, however, are timid of the water during the first month or six weeks of their lives and do not go into it. After the breeding season is over, that is, early in August, the mothers can be driven off and the young herded and handled like sheep. As each pup represents a mother, the problem became merely one of counting all the pups. This was accomplished and an account of the work for 1912 was given in the December 27 issue of SCIENCE.

As the census of 1912 was important to give exact information regarding the breeding stock at its lowest point, so a repetition of this census in 1913 became important to establish a measure of increase or expansion in this breeding stock. The total number of pups found in 1912 was 81,984. For the season of 1913 the total was 92,269, a gain of 12½ per cent. The normal annual gain of the herd arises from the accession of young three-year-old females coming upon the rookeries each season to bear their first pups. The theoretical rate of gain, as deduced from the quota of three-year-old males, taken in recent years,

should be about 25 per cent. The breeding life of the female is about 10 years. Approximately 10 per cent. of the adult stock of females disappear in each winter migration through natural termination of life, and the net gain of the herd should be about 15 per cent. That the gain of 1912 is 12½ per cent. instead of 15 is explained by the fact that the increment of three-year-old females for the past season was derived from the birthrate of 1910, when pelagic sealing was still in operation and pups in considerable numbers died unborn with their mothers or starved to death on the rookeries later because of the death of their mothers. In short the season of 1913 has not been quite normal. The season of 1914 should show normal conditions because its increment of gain will come from the birthrate of 1911, the first season under exemption from pelagic sealing. If the count of pups is repeated for that season, the normal rate of gain will be established.

All elements in the fur-seal census can not be measured by counts. The bachelor seals of four years and under, and the young females of two years and under, come and go from the sea in an irregular fashion which makes counting impossible. A basis of reasonably accurate estimate for these classes of animals, however, rests in the data arising from the quota of killable seals, and counts of animals rejected at the killings as too small or too large. Utilizing this form of estimate to supplement the counts of bulls, cows and pups, the appended completed census of the fur-seal herd is obtained, the figures for both 1912 and 1913 being given for purposes of comparison.

The stock of breeding and reserve bulls in 1913 shows an increase adequate to meet the needs of the expanding herd. The relation of the two sexes on the breeding grounds has in this season been more nearly ideal than at any time in the past 17 years. Could present conditions remain undisturbed, accurate information regarding the herd's future condition would be certain. Unfortunately this is not to be. The suspension of land killing, incorporated in the law of August 24, 1912, will break the present equilibrium and throw all factors of the problem into new confusion, by swamping the breeding grounds with an overstock of idle bulls. The real effect of the suspension is not at present visible, except in that the hauling grounds were in 1913 filled with superfluous young males, the killing of which was prevented by law. Ten thousand of these

FUR SEAL CENSUS

Class of Animals	Basis of Enumeration	1912	1913
Breeding bulls	Count	1,358	1,403
Breeding cows	Count	81,984	92,269
Reserve bulls—young	Count	199	259
Reserve bulls—adult	Count	113	105
Pups	Count	81,984	92,269
Bachelors—4-year-olds	Count and estimate	100	2,000
Bachelors—3-year-olds	Count and estimate	2,000	10,000
Bachelors—2-year-olds	Count and estimate	11,000	15,000
Bachelors—1-year-olds	Estimate	13,000	20,000
Young cows—2-year-olds	Estimate	11,000	15,000
Young cows—1-year-olds	Estimate	13,000	20,000
	Totals	215,738	268,305

animals (with skins worth $350,000 to $400,000), were left to grow up as useless fighting bulls, and this condition is to be multiplied through four more seasons. Its consequences ten years hence will prove a veritable calamity to the herd.

Leaving aside this discouraging feature of the situation, however, it is a source of genuine gratification that the suspension of pelagic sealing, accomplished by the treaty of 1911, has been so immediate and salutary in its effect. Not merely has the decline on the Pribilof Island rookeries—persistent through 30 years—been stayed, but the breeding herd has taken on a rapid growth. Its initial stock of 92,000 breeding females makes a splendid nucleus and will compound at an annual rate of 15 per cent.

George Archibald Clark

Stanford University, Cal.,
November 29, 1913

EDWIN KLEBS (1834–1913)

WITH the death of Edwin Klebs at Bern, Switzerland, on October 25, 1913, there passed away the last of the great pioneers of the bacterial theory of infection, a pupil of Virchow, a contemporary of Pasteur and, in a very definite sense, the inspirer of Koch. Born at Königsberg in 1834, Klebs was an East Prussian and the peculiar effect of his character upon his work, a certain discontinuity in the latter, was due to the Slavic element in his composition. He was a peripatetic all his life and, after serving as Virchow's assistant at Berlin (1861–66), he was successively professor of pathology at Bern (1866), Würtzburg (1872), Prague (1873), Zurich (1882) and Chicago (Rush Medical College, 1896), after which he lived in retirement at Dortmund and Bern. During all this time he was a prominent worker in all branches of pathology and in the truest sense a precursor in the bacterial theory of disease. Indeed, his greatest service to medicine was, perhaps, the important influence he exerted upon the pathologists of his time, leading them away from the solidist theories of Virchow and winning them over to the view that post-mortem findings are only end results and that infectious diseases are caused by microorganisms and their chemical products. Koch himself admitted, in a private letter, that he owed much to Klebs, who had been the actual path-breaker in many of the new fields followed by the younger men. Up to 1876, Klebs was the leading protagonist of the modern theory of specific infections (Pasteur did not begin to work in anthrax until about 1880), and, by actual priority of publication, he preceded Koch in the study of bacterial wound infections (1871) and in the technique of growing bacterial cultures in special media (hens' eggs in the first instance). During his Würzburg period, his idea of obtaining pure cultures of pathogenic microorganisms was actually laughed at as an idle dream. Long before Pasteur and Joubert, he showed that the blood of anthrax is not pathogenic after filtration (1871); in other words that the virus of the disease is non-filterable. From this idea, it was but a step for Loeffler to reason and to prove that diseases may be caused by "filterable viruses" (1898). Klebs saw the typhoid bacillus before Eberth (1881), the diphtheria bacillus before Loeffler (1883), investigated the tubercle bacilli of cold-blooded animals and their therapeutic possibilities before Friedmann (1900), inoculated monkeys with syphilis before Metchnikoff (1878), first investigated the bacteriology of gun-shot wounds (1872), first produced bovine infection of *Perlsucht* by feeding with milk (1873), first investigated the infectious nature of endocarditis (1878), and made the first exhaustive study of acromegaly (1884). Meanwhile, his two pathological treatises of 1869–76 and 1887–89 were acknowledged masterpieces in the older field of descriptive or morphological pathology, of which he was the leading exponent after Rokitansky and Virchow and in which Chiari is one of the few surviving workers. Klebs's definite abandonment of the solidist or "end result" pathology dates from his discourses of 1878 and 1882, which are definitely contra-Virchow, although nothing could be more courteous and reasonable than his attitude in joining issue with his old teacher and friend. In bringing the weak-kneed over to the modern view, his propagandism was of the broadest and most impersonal character. After 1876–8, Klebs's work was definitely overshadowed by Koch's great papers on anthrax and the traumatic infectious diseases, and his influence began to wane. It may be asked, why did this remarkable man not reap the fruits of his brilliant labors? Why is he not better known to-day? Some may find the answer in Lord Woolsey's dictum that "he alone is a good general who follows up his victories." But this reproach can not entirely be cast up to Klebs. His work was constantly interrupted by such occurrences as the revolution in Prague and the intrigues and internecine wrangles which sometimes go on among university professors. His temperament was restless, sensitive, impulsive and combative, and, being wrapped up in the original ideas which were always coming to him, he had a tendency to leave work of an important character to his assistants, which was not to his advantage.

Some of his ideas about infection, *e. g.*, his "bacillus malariæ," his "microzoon septicum" (wound infections), his "monadines" (rheumatic affections), turned out to be wrong, and where he struck into some good lead, as in diphtheria or typhoid, he was perhaps for this very reason little inclined to follow it up. Yet, all in all, Klebs was one of the most original spirits in modern medicine, a man who paid dearly for his unshakable confidence in humanity and his tendency to fight in the open, an opponent who soon forgot differences with his fellows and never cherished ill-will. He will remain where Osler has placed him as a great pioneer. He had a prophetic vision into the future and a fine historic sense, looking, as Wordsworth said of the poet, "before and after." His discourse on the history of medicine, delivered at Bern in 1868, may be likened to the little book of Stopford Brooke on Engish literature, as being the most delightful primer of the subject (as dissociated from surgery and the specialties) ever written. It deserves to be translated. Klebs was a founder and co-editor of the *Correspondenz-blatt für schweizerische Aerzte* (1871), the *Prager medicinische Wochenschrift* (1876), and he was, with Naunyn and Buchheim, a founder and for many years co-editor of the important *Archiv für experimentelle Pathologie und Pharmakologie* (1872). Naunyn, the distinguished clinician of Strassburg, who was Klebs's colleague at Bern, refers to him in the following terms:

> Ein langes Leben reich an Arbeit und an Unruhe. Wie er es sich selbst geschaffen, so hat er es hingenommen, ohne sich beugen zu lassen, ein aufrechter Mann bis an seinen Tod. Uns, seinen Freunden aus alter Zeit, sind sein offener Sinn, sein sprühender, anregender Geist, sein warmes Herz eine liebe, dankbare Erinnerung.

F. H. GARRISON

ARMY MEDICAL MUSEUM

SCIENTIFIC NOTES AND NEWS

THE annual meeting of the Physical Society will be held in Atlanta, Ga., December 29–January 3, the society meeting in joint session with Section B of the American Association for the Advancement of Science. The place of meeting will probably be the Georgia School of Technology. The program of ordinary technical papers will be in charge of the Physical Society, but two, or perhaps three, sessions will be in charge of Section B. These will be devoted to papers of general scientific interest, relating especially to some of the larger problems of geophysics. The program of the meeting will include the address of the president of the Physical Society, Professor B. O. Peirce, and that of the retiring vice-president of Section B, Professor A. G. Webster.

M. PAUL OTLET, of Brussels, sécretaire de la Union des Congrèses Internationales, who represented the Union at the Dundee meeting of the British Association for the Advancement of Science, will be present at the Atlanta meeting of the American Association for the Advancement of Science and will address the association on the subject of the international organization of scientific activities.

THE meeting of the Paleontological Society at Princeton will include a symposium on "The Close of the Cretaceous and Opening of Eocene in North America" with an introduction by Professor H. F. Osborn and Messrs. F. H. Knowlton, T. W. Stanton, W. J. Sinclair and Barnum Brown leading the discussion.

FOR the Australian meeting of the British Association in August next year, under the presidency of Professor W. Bateson, F.R.S., the following presidents of sections have been appointed:

Section A (Mathematics and Physics), Professor F. T. Trouton.
Section B (Chemistry), Professor W. J. Pope.
Section C (Geology), Sir T. H. Holland.
Section D (Zoology), Professor A. Dendy.
Section E (Geography), Sir C. P. Lucas.
Section F (Economics), Professor E. C. K. Gonner.
Section G (Engineering), Professor E. G. Coker.
Section H (Anthropology), Sir Everard im Thurn.
Section I (Physiology), Professor C. J. Martin.
Section K (Botany), Professor F. O. Bower.
Section L (Educational Science), Professor J. Perry.
Section M (Agriculture), Mr. A. D. Hall.

At the annual meeting of the New York Academy of Sciences on December 15, Dr. George F. Kunz was elected president. Vice-presidents for the sections were elected as follows: Professor Charles P. Berkey, Professor Raymond C. Osburn, Professor Charles Baskerville and Dr. Clark Wissler.

Dr. R. R. Gates has been awarded the Huxley gold medal and prize for research in biology at the Royal College of Science, London.

The special board for biology and geology at Cambridge University has adjudged the Walsingham medal for 1913 to Mr. Franklin Kidd, B.A., fellow of St. John's, for his essay entitled "On the Action of Carbon Dioxide in the Moist Seed in Maturing, Resting, and Germinating Conditions."

Mr. H. S. Jones, B.A., now one of the chief assistants at the Royal Observatory, Greenwich, has been elected to a fellowship at Jesus College, Cambridge.

Dr. W. Dawson Johnston has resigned the librarianship of Columbia University to become librarian of the St. Paul Public Library.

Professor A. W. Whitney, of the University of California, has resigned to accept a position in the state board of insurance.

Professor Charles Richmond Henderson, head of the department of practical sociology in the University of Chicago, has been made chairman of the educational committee on Chicago philanthropy, which was recently organized to keep the public informed of the needs of the city's poor.

Professor Clara A. Bliss, of the department of chemistry of Wells College, has been granted leave of absence for the year, and Miss Minnie A. Graham, formerly professor of chemistry at Lake Erie College, is substituting for her as head of the department.

The magnetic survey vessel, *Carnegie*, has returned to Brooklyn, thus completing the circumnavigation cruise begun in June, 1910, and covering a distance of over 70,000 miles. The vessel has been throughout under the command of W. J. Peters, and her work has been to determine the magnetic elements at sea in fulfillment of the plan of a general magnetic survey of the globe under the direction of the department of terrestrial magnetism of the Carnegie Institution of Washington.

A magnetic expedition covering a greater part of the District of Patricia, Canada, was undertaken this summer by the department of terrestrial magnetism and brought to a successful conclusion under the charge of Dr. H. M. W. Edmonds, assisted by Observer D. M. Wise. A particularly interesting and important feature of this field work was the proximity of the line of observations to the supposed region of maximum total intensity first disclosed by Lefroy in 1845. The party left Washington May 16, 1913, and returned at the end of October. The main part of the work comprised the canoe route of approximately 2,000 miles, of which over 500 miles was over an unsheltered open coast along Hudson Bay and James Bay from Fort Severn to Fort Albany. Complete magnetic observations were secured at 38 different points.

The annual lecture before the Carnegie Institution of Washington was given on December 16, in the assembly room of the Administration Building on "Measurement of Environic Components and Their Biologic Effects" by Dr. D. T. MacDougal, director of the Desert Laboratory, Tucson, Arizona.

The department of anthropology of the American Museum of Natural History, New York City, offers a course of four lectures dealing with the social and religious customs and beliefs of primitive peoples. On January 8 and 15, Dr. Robert H. Lowie will lecture on "Social Organization," and on January 22 and 29 Dr. Pliny E. Goddard will lecture on "Religious Observances" and "Religious Beliefs."

Professor W. W. Atwood, of Harvard University, presented on November 29 to the Chaos Club, an organization composed of the members of the science faculties of the Universities of Illinois, Wisconsin, Northwestern and Chicago, an account of his recent discovery of glacial material of Eocene age in the San Juan Mountains of southwestern Colorado. This Eocene till is the only evi-

dence that has thus far been found in the world of a glacial period at that time in the history of the earth.

"THE Strength and Weakness of Socialism" was the subject of an address by Professor Albion W. Small, head of the department of sociology and anthropology in the University of Chicago, delivered on December 28 in the Fine Arts Theater, Chicago, under the auspices of the University Lecture Association. On January 6, Professor James R. Angell, head of the department of psychology, will speak in the same place on the subject "Practical Applications of Psychology."

THE family of the late Dr. Alfred Russel Wallace having invited Mr. James Marchant, of Lochnagar, Edenbridge, Kent, to arrange and edit a volume of letters and reminiscences, those who have letters or reminiscences are requested to send them to him. The letters would be safely and promptly returned.

THE twenty-fifth anniversary of the Institut Pasteur was celebrated November 13. Speeches were made by the president of the republic and Dr. Roux, director of the institute.

THE descendants of Priestly, the discoverer of oxygen, have presented to the University of Pennsylvania the chemical balance which was used by him in his experiments.

AT the fifth International Congress of Mathematicians, held at Cambridge, it was decided that the sixth congress should meet at Stockholm in 1916. The king of Sweden, who has bestowed his patronage upon the congress, has decided to honor, by means of a gold medal with the likeness of Karl Weierstrass and by a sum of 3,000 crowns (about $825) some important discovery in the domain of the theory of analytical functions. Those who wish to compete must send their manuscripts to the chief editor of the *Acta Mathematica* before October 31, 1915, the centenary of the birth of Karl Weierstrass.

THE council of the British Association, acting under authority of the general committee, has made the following grants out of the gift of £10,000 made to the association for scientific purposes by Sir J. K. Caird at the Dundee meeting of the association last year. (1) £5[illegible] to the committee on radiotelegraphic investigations. (2) An annual grant of £100 to the committee on seismological investigations, which is carrying on the work of the late Professor John Milne. (3) An annual grant of £100 to the committee appointed to select and assist investigators to carry on work at the zoological station at Naples. (4) £250 towards the cost of the magnetic re-survey of the British Isles, which has been undertaken by the Royal Society and the British Association in collaboration.

UNDER the auspices of the international commission a congress on the teaching of mathematics will be held at Paris, April 1–5, 1914, in the halls of the Sorbonne. The chief subjects of discussion will be the introduction of the first notions of the calculus and of primitive functions in the secondary schools, and the teaching of mathematics to engineering students.

AN international conference met in Paris on December 10 to discuss the question of a map of the world on a millionth scale. General Laffon de Ladebat, who is director of the geographical service of the French army, welcomed the delegates of the thirty-two countries represented on behalf of the government, and Colonel Close, the chief English delegate, replied. The first conference was held in 1909 in London, and since then specimen sections of the map have been prepared. These were produced for inspection. The scale proposed is equal to 15 miles to the inch.

THE International Electrical Congress is to be held at San Francisco from September 13 to 18, 1915, under the auspices of the American Institute of Electrical Engineers by authority of the International Electrochemical Commission, and during the Panama-Pacific International Exposition. Dr. C. P. Steinmetz has accepted the honorary presidency of the congress. The deliberations of the congress will be divided among twelve sections which will deal exclusively with electricity and electrical practise. There will probably be about 250 papers. The first membership invitations will

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Ac issued in February or March, 1914. Attention is drawn to the distinction between this Electical Congress and the International Engineering Congress which will be held at San Francisco during the week immediately following the electrical congress. The engineering congress is supported by the societies of Civil, Mechanical and Marine Engineers and by the institutes of Mining and Electrical Engineers, as well as by prominent Pacific Coast engineers who are actively engaged in organizing it. This congress will deal with engineering in a general sense, electrical engineering subjects being limited to one of the eleven sections which will include about twelve papers, treating more particularly applications of electricity in engineering work. The meeting of the International Electrotechnical Commission will be held during the week preceding that of the Electrical Congress.

THE third volume of the "Annual Tables of Constants and Numerical Data, Chemical, Physical and Technological," published by the International Commission of the Seventh and Eighth International Congresses of Applied Chemistry is now in press and will be issued in the first half of 1914. A descriptive circular with references to reviews of previous volumes may be secured on application to the University of Chicago Press. The commissioners for the United States are: Julius Stieglitz, the University of Chicago; Edward C. Franklin, Leland Stanford University; Henry C. Gale, the University of Chicago, and Albert P. Mathews, the University of Chicago.

BEGINNING with January, 1914, the American Breeders' Association will be known as the American Genetic Association. At the same time (starting with Vol. V., No. 1) *The American Breeders' Magazine* will be enlarged in size and called *The Journal of Heredity*. The cooperative nature of the association will remain unchanged, and the present scope and character of the magazine will be maintained, but its quality will be still further improved.

A BACTERIOLOGICAL club has recently been organized at the University of Illinois with a membership of fifteen. The organization held its first meeting on Monday evening, December 8, at which an address was given by Dr. Thomas J. Burrill who reviewed the history of bacteriological research. Membership in this club is open both to faculty and to graduate students. Earlier in the year a similar society was organized for the purpose of studying botanical subjects.

THE National Physical Laboratory, Teddington, is in possession of the British radium standard, which has been certified by the International Radium Standards Committee after comparison with the international radium standard now deposited at the Bureau International at Sèvres. The laboratory is prepared to determine the contents of radium and mesothorium preparations by comparison with the standard.

WITHIN the last month the University of Arizona has installed a Callendar pyrheliometer with a Leeds and Northrup recording galvanometer. This type of pyrheliometer consists of a horizontal surface, measuring the vertical component of sky radiation. This surface is made up of two platinum resistance circuits, one blackened, the other bright, mounted in a vacuum. These two circuits form two sides of a Wheatstone bridge, the resistance necessary to balance the bridge being recorded on the sheet. The recording galvanometer has five ranges, one adjusted to this pyrheliometer and the others to various forms of resistance thermometers. The instruments were purchased on the income of a fund presented by Dr. James Douglas, of New York. For standardizing the records, the university has also a Smithsonian silver disk pyrheliometer. It is designed thus to have a permanent record of sky radiation, not only for the purpose of getting data regarding solar energy in that dry and exceptionally clear climate but also for checking any suspected large variations in the solar constant.

UNIVERSITY AND EDUCATIONAL NEWS

AN addition to the resources of the University of Chicago is the completion of the addition to the Ryerson Physical Laboratory, and the reconstruction of the other part of that building. This work increases the re-

sources of the laboratory for research at least threefold. The cost of the addition and reconstruction was about $200,000, and was the gift of the president of the university board of trustees, Mr. Martin A. Ryerson.

FOUR distinct building projects are going forward at the Carnegie Institute of Technology, involving an expenditure of approximately $750,000. The concrete foundations are now ready for the steel work in the central building and on the new wing for the Margaret Morrison Carnegie School for Women. The former is to be occupied by the general executive offices and a students' union. Machinery Hall, to house the electrical and mechanical engineering departments, is nearing completion. The high tower, the last piece of work to be done on this structure, will be finished within another month. The front section of the school of design building, including the auditorium, the exhibition rooms and the sculpture work on the exterior, is also still under construction. The following new appointments to the faculty of the school of applied science were made this year: Thomas G. Estep, instructor in mechanical engineering; Charles R. Fettke, instructor in geology; S. Leslie Miller, instructor in civil engineering; Andrew S. Yount, instructor in physical chemistry; Charles P. Mills, instructor in mathematics, and Donald H. Sweet, instructor in physics laboratory.

THE trustees of Barnard College, Columbia University, announce that Mrs. Clinton Ogilvie has promised to contribute $10,000 toward $1,000,000 now being raised for endowment.

FOUR thousand dollars to the Massachusetts Institute of Technology for a scholarship preferably to aid Jewish students is a bequest of the late Louis Weissbein, the Boston architect.

THE late Dr. Gavin Paterson Tennent, of Glasgow, by his will bequeathed his entire fortune in medical charity. To the University of Glasgow he left £25,000, as endowment for the faculty of medicine.

THE committee in charge of the Sarah Berliner Research Fellowship for Women offers annually a fellowship of the value of one thousand dollars, available for study and research in physics, chemistry or biology, in either America or Europe. This fellowship is open to women holding the degree of doctor of philosophy, or to those similarly equipped for the work of further research; applications for this fellowship must be in the hands of the chairman of the committee, Mrs. Christine Ladd-Franklin, 527 Cathedral Parkway, New York, by the first of January of each year.

PROFESSOR ERNEST MERRITT, of Cornell University, has resigned as dean of the graduate school, the resignation to take effect in June, 1914. Professor Merritt will remain at Cornell, and will devote all his time hereafter to the work of the department of physics.

THE following promotions have been made in the College of the City of New York: Frederick G. Reynolds to associate professor of mathematics. To be assistant professor: R. Stevenson in chemistry; M. Philip in mathematics; A. J. Goldfarb and G. G. Scott in natural history. To be instructor: G. M. Brett in mathematics; F. Woll in physical instruction.

THE following appointments have been made in the school of medicine, University of Pittsburgh: Dr. J. A. Hagemann, instructor in laryngology; Dr. F. V. Lichtenfels, demonstrator in laryngology; Dr. August Soffel, instructor in laryngology; Dr. A. P. D'zmura, demonstrator in medicine; Dr. G. C. Weil, demonstrator in surgery; Dr. E. W. zur Horst, demonstrator in medicine; Dr. A. W. Duff, demonstrator in otology; Dr. H. H. Permar, demonstrator in pathology; Mr. H. N. Malone, student assistant in anatomy. Dr. Ellen J. Patterson has been promoted from assistant professor of laryngology to associate professor.

DR. H. M. SHEFFER, recently instructor in mathematics in Cornell University, has been appointed instructor in philosophy in the University of Minnesota.

DR. GWILYM OWEN, lecturer on physics at Liverpool University, has been appointed professor of physics at Auckland University College, New Zealand.

PROFESSOR ROEMER, of Marburg, has been called to Greifswald to conduct the hygienic institute as the successor of Professor Loeffler.

DISCUSSION AND CORRESPONDENCE

A NEW TYPE OF BACTERIAL DISEASE

BY this title I mean a disease in which the bacterial growth first develops conspicuously as a thick layer on the surface of the plant, and only later penetrates into its interior.

Ráthay's disease of orchard grass (*Dactylis glomerata*) described by him in 1899 may be taken as the type of this kind of disease. In 1913 I had opportunity to verify Ráthay's statements[1] on material sent to me from Denmark by Professor Kølpin Ravn, and to make pure cultures and further studies of the organism which in honor of Ráthay, may be known as *Aplanobacter ráthayi* n. sp., with the characters assigned to it by Ráthay, and in addition the following:

Nitrates are not reduced; gelatin is finally liquefied, but liquefaction is visible only after some weeks and progresses very slowly; it does not grow in Cohn's solution; growth starts off slowly in milk, but is prolonged with formation of a copious chrome yellow precipitate and a wide bright yellow rim; litmus milk is first slowly blued, but becomes purplish after some weeks; it grows so slowly on agar that poured plates which appear to be sterile may eventually give small yellow colonies. Nearly all of Ráthay's statements have been found to be correct. This note is here published because of delay in the issue of a longer account.

ERWIN F. SMITH

[1] *Sitz. Ber. Wiener Akad.*, 1 Abt., Bd. CVIII., p. 597.

THE MANUS OF TRACHODONT DINOSAURS

IN a recent article in *The Ottawa Naturalist*,[1] Mr. Lawrence M. Lambe has described "The Manus in a Specimen of *Trachodon* from the Edmonton of Alberta," illustrated by three figures. According to Mr. Lambe's interpretation of the Ottawa skeleton the phalangeal formula is as follows:

Digit II. with three phalanges, the third bearing a hoof.

Digit III. with three phalanges, the third bearing a hoof.

Digit IV. with two phalanges, the second bearing a hoof.

Digit V. with two phalanges, the second bearing a hoof.

Whereas in a specimen that I have described the formula is

Digit II. with three phalanges, the third bearing a hoof.

Digit III. with three phalanges, the third bearing a hoof.

Digit IV. with three phalanges, the third a vestigial bone without hoof.

Digit V. with three phalanges, the third a vestigial bone without hoof.

The writer published a description of the manus of *Trachodon annectens*,[2] based on the first reported specimen in which all of the phalanges are present. In this specimen the full number of phalanges are not only present but each digit is articulated either in the right or the left hand and all are encased in a thin layer of matrix in which the skin impression is preserved.

In this uncrushed specimen the long slender metacarpals of digits II., III., and IV. are closely appressed as represented in the figure accompanying the above article, a position verified by structure and by position in three other uncrushed specimens in the American Museum, one in the National Museum, and a sixth in the collection of the Calgary Natural History Society.

In no specimen of the genus *Trachodon* known to me have more than two hoof bones been found in the manus—those of digits II. and III. The terminal phalanges of digits IV. and V. are, when uncrushed, rounded bony nodules, very much reduced and were not covered by a hoof or nail.

If Mr. Lambe's interpretation is correct we have a remarkable specific variation in this genus in which a later species, described by me, has developed an additional phalanx on each

[1] Vol. XXVII., pp. 21–25, 1913.

[2] *Bull. Am. Mus. Nat. Hist.*, Vol. XXXI., Art. X., pp. 105–107, 1912.

of the two degenerate digits. But I think the evidence is not sufficiently conclusive to warrant his interpretation. The skeleton which I have examined is more than two thirds complete, much crushed, and but few of the phalanges are articulated. It seems quite possible to interpret the phalangeal formula in conformity with other Trachodont skeletons in which the phalanges, being not only fully articulated but enclosed within the web of the skin, are not open to any possibility of error.

In Plate II. showing what Mr. Lambe considers the natural position of the elements the terminal hoof of IV. is evidently II.[3] and V.[2] is not a terminal as I have determined by examination.

BARNUM BROWN
AMERICAN MUSEUM OF NATURAL HISTORY
November 20, 1913

AGRO-DOGMATOLOGY

IN SCIENCE of October 3, 1913, there appears under the title "The Bread Supply" a veritable vegetable cell containing a *nucleus* in the form of a quotation from an address by Professor Bolley; some *cytoplasm* of somewhat alkaline reaction provided by Professor Hopkins; *chromatophores* for which various experiments are called upon to furnish local color; *metaplasm* containing a conglomeration of non-essentials, incidentals and chemical dogma; scarcely enough juice to fill even a small *tonoplast;* an impermeable *ectoplasm*—the whole cell suffering from extreme plasmolysis resulting from the toxic fumes arising from very decadent notions of "plant food."

Professor Hopkins refers with "deep respect" to "the science of biochemistry, as the chief means of making plant food available." With such a conception of its nature it would be better to refer to biochemistry with reverence—an attitude of mind often assumed towards the unknown. The biochemist and plant physiologist might well say to Professor Hopkins, as did the Lord to Moses, "Put off thy shoes from off thy feet, for the place whereon thou standest is holy ground."

We are told that Jensen devised a method for "the destruction of fungous diseases sometimes carried in seed grain." I do recall that Professor Jensen developed the so-called "hot water" method for the destruction of the spores of certain fungi known to cause diseases of certain cereals. When such simple facts regarding plant pathology are available in even our elementary text-books it is evident that "no state in the union can afford . . . to have the minds of its farmers and land owners befogged in relation thereto."

In making analyses of commercial fertilizers, soils, ores and similar materials the "analytical chemist" still plays an important rôle; he may even assist in prolonging human life by detecting sodium benzoate in our canned tomatoes. but no one seriously expects him to fully comprehend, even "two or three centuries after its discovery," the relation of the plant to its environment. In "belittling" the work of the analytical chemist in this connection even a hundred columns of words are not so effective as a comparison with the actual achievements of the biochemist and the plant physiologist.

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SCIENTIFIC BOOKS

Nervous and Mental Disease Monograph Series. Edited by DRS. SMITH ELY JELLIFFE and WM. A. WHITE. Published by the Journal of Nervous and Mental Disease Publishing Company, New York.

This series, it is announced, "will consist of short monographs, translations and minor text-books." To judge by the rapidity with which the successive numbers have appeared and by the promptness with which the editions have become exhausted, the undertaking is certainly well conceived. The first 15 numbers include White's excellent "Outlines of Psychiatry," a condensed text-book of 300 pages; "Mental Mechanisms" by the same author; Franz's "Handbook of Mental Examination Methods," and two other original papers, the remaining numbers being translations. Of these, one of the most important is Kraepelin's study of "General Paresis." There are

Several translations of works of the "psychoanalytic school," including Freud's "Selected Papers on Hysteria and Other Psychoneuroses" and "Three Contributions to Sexual Theory." The editors of the series, being themselves interested in this movement, are helping to make the psychoanalytic authors accessible in English. As the limits of this review evidently do not admit of an analysis of the whole series of papers, we may confine ourselves to a few remarks on Freud and his school. The two numbers translated from Freud perhaps give as good an insight into the core of his doctrine as could be had in small compass. It is, however, characteristic of this author that cross references are very important in getting his meaning. Everywhere there are gaps in the argument that need to be supplied from some other paper or book; in fact, a reading of all Freud's works still leaves the impression of unbridged gaps, jumps in the thought and incompleteness of evidence. Quite possibly, these deficiencies are inherent in the doctrine at its best, but it is at least to be hoped that some Freudian with a taste for orderly exposition should show what can be done towards giving this fascinating theory a scientific dress.

The whole scope of the Freudian doctrines is very far-reaching, involving a treatment of hysteria and other psychoneuroses, a theory of the mechanism of these disorders, certain significant views on normal as well as pathological mentality, and even certain strictures on the ethics of civilized society. In his psychology, Freud lays stress on the importance of repressed desires, and on the devices by which these desires, though relegated to the "subconscious," yet contrive to express themselves in dreams (every dream being a dramatized or symbolic fulfilment of a repressed wish), in witticisms, and in slips of memory and similar lapses. He is fond of insisting that lapses and apparent irrelevances and extravagances of thought or action do not occur without a cause—by which he means that they do not occur without an emotional and volitional cause. We forget a name because, subconsciously, we wish to forget it, we make a slip of the tongue because some subconscious wish expresses itself in this way, we indulge in witticisms because by them we can give expression to wishes which social custom forbids us to express directly, or which we even do not acknowledge to ourselves. Now society is specially insistent on the repression of sexual wishes; and for this reason, and because sex is a dominant factor in human make-up and because man is driven to "sexualize everything," the repressed wishes which express themselves in dreams and lapses are chiefly and fundamentally of a sexual nature. Furthermore, the repression of sex motives begins early in childhood, for the child is not the sexless creature that he is often supposed to be, but is, on the contrary, strongly sexed from the very start. In part, his sexual proclivities are self-centered and do not drive him to persons of the opposite sex—an infantile condition which persists in some individuals in the form of sexual perversions—but in part, the polarity of the sexes appears already in the young child, so that the boy is sexually attracted to the mother and becomes in his own mind a rival of the father. These sexual proclivities, being socially repressed from a very early age, generate submerged emotional "complexes" which persist from childhood to adult life and form the deepest stratum of that subconscious life of desire which finds expression in dreams, etc. Thus the full analysis of a dream or lapse leads to a suppressed wish, to a sex motive, and ultimately back to the sexual life of childhood. Suppression, sex and infantilism are the three fundamentals of the Freudian psychology.

This psychology is readily applied to the explanation of hysteria, or rather it grew out of a study of hysteria. The "attacks" and other abnormal behavior of hysterics are, like dreams, the expression of repressed sexual wishes dating back to childhood. Often some shocking or disappointing experience of a sexual nature has been repressed from memory, but its "affect" or emotion remains and

invents some substitute for the suppressed memories, thus giving rise to the tics, paralyses, pains, anesthesias and amnesias which continually torment the patient, while occasionally the repressed memories, bursting through the barriers of suppression, take control of consciousness and produce the "attack."

The treatment of hysteria is, accordingly, to discover the suppressed memories and wishes, and satisfy them by "abreaction." The wish must be dealt with in the full light of consciousness. The reaction to it need not be the direct accomplishment of the wish in its original form, but may be "sublimated." The reaction may consist in the quasi-sexual relation between the (usually female) patient and the psychoanalyst, a relation carefully guarded and yet perfectly frank, in which sexual wishes are openly acknowledged and the memories connected with them are ferreted out and rehearsed at length. It is to the method adopted for ferreting out the repressed wishes and memories that the term "psychoanalysis" is most directly applied. The plan is to remove the repression as far as possible, and let the patient's thoughts move freely, in the hope that they will move towards what is repressed. Often a dream of the patient is taken as the starting point, and he is asked to let his thoughts play freely about the items of the dream. This free play of thoughts is called "free association"; but since association is seldom, if ever, perfectly free, the process needs to be examined a little more closely in order to find out what "control" is exerted upon association. The subject is encouraged to look for something emotionally significant and for something which he is tempted to repress; eventually, his thoughts are steered in a sexual direction. The operator, convinced beforehand that this is the direction in which fruitful results are to be found, more or less overtly steers the patient's thoughts. This analysis of the patient's subconscious wishes and memories is a time-consuming process, and of late there is an increasing tendency to take short-cuts by the use of dream symbolism. It appears that certain objects dreamed about, gardens, snakes, stairs and a host of others, are fixed sexual symbols, and, being so interpreted by the operator, enable him to make rapid strides at the beginning of his analysis.

The above inadequate account of Freud's teaching scarcely affords a basis for appraising its scientific or practical value. At the present time, the data are simply not at hand for such an appraisal. Current discussion of the doctrine has not yet reached the level of scientific consideration. The opposition has been characterized by derision and indignation, and the counter-argumentation of the Freudians by repartee rather than by evidence. From the Freudian point of view, opposition is to be expected because men are unwilling to admit their own repressed complexes and the extent to which their lives are dominated by sex. This indicates the manner in which Freudians handle their opponents, and it is certainly not a manner calculated to lead to dispassionate consideration. The result is that there is not a point in the whole Freudian system which can be regarded as either proved or disproved. The evidence as presented by the Freudians is too full of jumps and gaps to be logically convincing, and it would seem that those who embrace the doctrine—as several eminent neurological practitioners, especially in this country, have embraced it—have been not so much convinced as converted—that they have adopted Freudism as a faith, finding it justified by its works, and desiring themselves to practise these works. In other words, they have found the *treatment* efficacious; and the principal argument in favor of the doctrine has been the success of the treatment. (It should be said that there are decidedly two opinions regarding the value of the treatment, and the present reviewer is in no position to pass judgment in this matter.) The weakness of this argument is that it would prove the truth of many rival systems—animal magnetism, Christian Science, "new thought," divine healing, Yoga, osteopathy—each of which meets with appreciable success in treating hysterical and other neurotic cases. Consid-

as a scientific hypothesis, the doctrine of Freud suffers from the disability that it apparently can not be put to a crucial test; for whichever way the test came out, the Freudian would find in the result a confirmation of his views. For example, a dream is always the expression of a repressed wish; but if a particular dream that is brought forward seems not to be the expression of a wish, it can be regarded as expressing the wish that the Freudian doctrine be not confirmed, or as expressing a subtle and subconscious opposition of the patient to the operator. Or, again, the open expression of sexual interests by a young child is clear evidence in favor of "infantile sexuality," while the absence of such expression is an evidence of "repression." It is somewhat disconcerting to find that what is ostensibly a psychological hypothesis, to be tested, is in reality a faith to be embraced or rejected.

The sociological implications of the Freudian conception are obvious. Nervous disturbances and much minor mental inefficiency, being due to the repression of sexual motives which is enjoined by civilization, point the way to a reform of society in the direction of greater tolerance and freedom for sexual impulses.

Even anthropology is invaded by the psychoanalysts. Myth and folklore are regarded by them as phenomena analogous in the race to the dreams of an individual, and as expressing in symbolic form the repressed wishes of the race and especially of the childhood of the race. All myths are therefore fundamentally sexual. This line of interpretation, originated by Freud himself, is represented in the present series by Abraham's paper on "Dreams and Myths," which considers especially the story of Prometheus, and endeavors to show that in its earliest form it had distinctly a sexual meaning, later overlaid by more "refined" interpretations. The fire of Prometheus is a sex symbol. Abraham's treatment has one or two obvious weaknesses. He fails to show that repression of sex matters was so strong in the childhood of the race as to create a need for symbolic expression—for it must be remembered that the symbol, according to Freud, comes into play when direct expression is not allowed by the personal or social "censor." This censorship is usually regarded as a characteristic—and defect—of civilization, and why then should it be carried away back to the origin of myths? Even grant the dictum, probably exaggerated, that "man sexualizes everything," we need not conclude that the sex motive is always repressed, to reappear in symbolic form. Fully as plausible would be an exactly opposite, though still sexual, theory of myths, namely, that primitive man, being familiar with reproduction, used it as a symbol or paradigm for interpreting other natural phenomena, so that the sex idea, instead of requiring indirect expression in terms of fire, etc., itself furnished the means for expressing primitive ideas regarding these other phenomena. When, for example, the early Greeks inquired regarding the "physis" or generation of the world, they were using reproduction as a basis for conceiving world processes. Other phenomena were not employed as symbols for sex, but sex was used as a symbol for other phenomena.

If all these ramifications of the psychoanalytic views were modestly put forward as tentative hypotheses, they would awaken interest; and if they were thoroughly worked out and made as precise and systematic as possible, they would deserve serious consideration; but, as a matter of fact, they are presented at once with characteristic sketchiness and cock-sureness. It is a little surprising to find practical physicians interesting themselves in myths and fairy tales. Their reason is thus stated in the preliminary announcement of *The Psychoanalytic Review: A Journal Devoted to an Understanding of Human Conduct*, edited, like the Monograph Series here under review, by Drs. White and Jelliffe and published also by *The Journal of Nervous and Mental Disease*, the first number bearing date of October, 1913: "Briefly stated, the hypothesis which attempts to fathom the laws governing human conduct is the principle that has already done service in the field of biology. It is the recapitulation hypothesis that ontog-

ogy is a condensed phylogeny. . . . The mind as it is to-day, like the body as it is to-day, can only be adequately understood in the light of its developmental history throughout the ages of the past. . . . The fields of comparative theology and comparative mythology, of folklore and fairy tales, are rich in material of very practical significance in our present-day problems. . . . Mental disease in its destructive results brings the individual back to primitive and archaic methods of reaction,—reactions which may be better understood when we have studied the mind of primitive man and seen there what they mean." It is certainly satisfactory to psychologists and anthropologists to find their subjects thus enlisting the interest and cooperation of a large body of physicians, and the only apprehension is that the psychoanalytic method, applied in the armchair to the records of primitive man, may appear to the working anthropologist as somewhat lacking in directness and thoroughness.

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The Venom of Heloderma. By LEO LOEB.

Few portions of the world where reptiles occur at all are without some species of serpent venomous enough to be dangerous to human beings. The nature and mode of action of the poison of various serpents has, therefore, been of much practical interest and has attracted the serious attention of investigators in many lands. Nearly all lizards, on the contrary, are harmless. Indeed, the only species known to be venomous are the two kinds of Gila monsters found in Mexico and on our own southwestern deserts of New Mexico, Arizona and Nevada. Perhaps because of its more purely scientific interest, the venom of these lizards has received comparatively little study. The only careful investigations have been by Mitchell and Reichert, Santesson, Van Denburgh and Wight. While these authors have agreed as to the deadly nature of the venom of these lizards they have differed in many points as regards its mode of action.

In a paper of some two hundred and forty-four pages issued by the Carnegie Institution of Washington[1] one finds a series of articles in which are set forth the results of investigations of the poison glands and venom of the poisonous lizards of the genus *Heloderma*. These articles are by Leo Loeb and a large number of collaborators who made use of the Laboratory of Experimental Pathology of the University of Pennsylvania.

The anatomy and histology of the poison glands are described and it is stated that *Heloderma horridum* has the same anatomical arrangement as has been described in the case of *H. suspectum*. It is shown that pilocarpine increases the flow of venom and that transplanted portions of the gland retain their toxic character. Venom was not found in the blood or organs of *Heloderma*, except in the poison glands. It would thus appear that the venom is formed in these glands, not selected and excreted by them, and that there is no internal secretion of venom.

Gila monster venom affects mainly the central nervous system, and death is mainly due to paralysis of the respiratory center. There is a marked primary fall in blood-pressure of vasomotor origin. Diminution in the flow of urine is merely the result of the decrease in blood-pressure. Structural changes in the tissues of the poisoned animal are very slight, but extravasations of blood sometimes occur.

Gila monster venom is stated to cause hemolysis only in the presence of some activator such as lecithin and certain blood sera. It has no cytolytic power except upon the erythrocytes.

Heloderma is immune to its own venom. That is not due to the presence of antitoxin in its circulation.

Dr. Alsberg "succeeded in obtaining the *Heloderma* venom in a state in which it no longer gave the biuret reaction, thus proving

[1] "The Venom of *Heloderma*," by Leo Loeb, with the collaboration of Carl L. Alsberg, Elizabeth Cook, Ellen P. Corson White, Moyer S. Fleisher, Henry Fox, T. S. Githens, Samuel Leopold, M. K. Meyers, M. E. Rehfuss, D. Rivas and Lucius Tuttle, Washington, D. C., May 10, 1913.

its poisonous principle is a substance from proteid or only secondarily combined with it."

No local effects were observed at the point of injection of Gila monster venom, and no curare-like action was noted. No marked changes in the clotting time of the blood of animals under the influence of *Heloderma* poison were found.

These studies confirm, in the main, the investigations of Van Denburgh and Wight. Perhaps the principal difference in the two series of observations is regarding changes in the clotting time of the blood. The present investigators report no observed change in clotting time, while Van Denburgh, in pigeons subjected to *Heloderma* venom, found the blood firmly clotted in the auricles while the heart was still beating, and Van Denburgh and Wight observed that a primary shortening in the clotting-time was often followed by a complete loss of coagulability.

The results set forth in this volume by Leo Loeb and his collaborators constitute a valuable addition to our knowledge of reptile poisons. One can not but feel, however, that these results would be more readily available if given in much less extended form, nor need one be an emotionalist to doubt whether these results justify the experimental injection of venom into "more than 360 warm-blooded animals" in addition to many cold-blooded ones.

JOHN VAN DENBURGH

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SPECIAL ARTICLES

ANATOMY AS A MEANS OF DIAGNOSIS OF SPONTANEOUS PLANT HYBRIDS

IN the genetical studies, which have assumed so large and justly prominent a position in biological work during the past few years, external characters have been investigated almost exclusively. It has in fact been quite generally assumed that plants which resemble one another externally either belong to the same species or are at best only varieties of the same species. Nevertheless it is true that the geneticist has often found it necessary, in his work, to secure by continued cultivation, "pure lines" of the plants he uses in his breeding investigations.

The intention of the present communication is to indicate that spontaneous hybrids are of extremely common occurrence either identical in appearance with recognized species or varying so slightly and constantly over wide areas from the norm, that they are recognized as merely varietal modifications of recognized species. They can often nevertheless be clearly diagnosed as hybrids by the investigation of their internal anatomy both vegetative and reproductive. The full data of these observations, accompanied by the necessary illustrations, will be published elsewhere.

It will be convenient to consider first the case of identical external structure covering profound differences in internal organization. In the course of anatomical experimental investigations, carried on in the laboratories of plant morphology of Harvard University, on some of the lower amentaceous Dicotyledons, specially directed towards the elucidation of the hitherto unrecognized but highly important relation of wood rays to genetical and phylogenetic sequence, material of *Betula pumila,* from the Arnold Arboretum of Harvard University, diagnosed as such both by the Arnold Arboretum and the Gray Herbarium, showed profound differences in organization from wild material of the same species, secured from widely separated localities in the eastern United States and Canada. Vegetatively the Arnold Arboretum specimens presented striking aggregations of wood rays in segments of the woody cylinder, such as are characteristic of the more primitive birches and alders, and in this respect presented a marked contrast to normal *B. pumila,* where rays of this type can not be said to occur. These peculiarities suggested its hybrid origin and the reproductive structures of the abnormal material were investigated for evidence for or against this hypothesis. Male cones examined early in March showed in the sporogenous regions of the anthers large areas of abortive spore-mother cells. Late in April it

was further observed that even in the case of the functional mother cells, that the tetrads frequently produced but one normal pollen grain, the other three persisting as mere vestiges, attached to the germination pores of the completely formed grains. In normal *B. pumila* abnormalities of this nature were not found. Another interesting feature of the development of the microsporangium in the material from the Arnold Arboretum was the abortion of the mechanical or fibroid layer of the anther wall, which in normally developed spore sacks is responsible for the dehiscence of the anthers. Both these features of the stamens of the specimens under discussion, viz., the abortive pollen and the degenerate anther wall, point unmistakably to their hybrid origin.

Professor Jack has been good enough to supply the history of the plants of *B. pumila*, growing in the Arnold Arboretum. They were derived from seed obtained from plants propagated at the Arboretum from wild seed of the species, secured by Professor Sargent in Vermont. A few of the group of individuals thus obtained were clearly hybrids between *B. pumila* and near growing large trees of *B. lenta*. The peculiarities of ray-structure referred to above, namely the aggregation phenomena, are found in neither *B. pumila* nor *B. lenta*, and are doubtless the result of the increased vigor of heterozygosis, as has been noted by Professor East and others. It appears quite obvious, from the various data described here, that the plants of *B. pumila* at the Arboretum, although resembling that species absolutely in external form, are in reality hybrids, as inferred from their more important anatomical features.

The next illustration of the value of anatomical data in the diagnosis of hybrids is taken from the genus *Equisetum*. The species of this genus known as *E. littorale* has long been recognized in Europe and this continent as a hybrid between *E. arvense* and *E. limosum*. It presents transitional features in its external form and internal anatomy between these two species and moreover is characterized by the production of large numbers of abortive spores, which are generally the "elaters" attached to normal *Equi*[illegible] spores. The genus *Equisetum* is chara[illegible]ized both in this continent and in Europe the large number of varieties of its specie[illegible] which occur spontaneously (these would probably be designated by mutationists of the De Vriesian school as "elementary species"). One of these numerous varieties is here taken as an illustration of the value of anatomy in genetical work. Professor Jeffrey observed in material of *E. variegatum* var. *Jesupi*, gathered on Toronto island, that a large number of the spores were abortive and without elaters. A detailed anatomical investigation of this material and of other specimens, including the type, kindly supplied for this purpose by the Gray Herbarium of Harvard University, showed that not only are the spores largely abortive in *E. variegatum* var. *Jesupi*, but that the sporangium wall is also degenerate, lacking the mechanical or fibrous layer. The aerial and subterranean stem further showed a condition of organization intermediate between that found in *E. hiemale* and *E. variegatum*. *E. variegatum* var. *Jesupi*, is consequently not to be regarded at all as a variety or "elementary species," but as a clear hybrid, in all probability between *E. hiemale* and *E. variegatum*. The writer hopes later to publish extended observations on a number of the "varieties" of species of *Equisetum*.

In conclusion it may be pointed out that the investigation of the anatomy of recognized or crypthybrids is likely to be of great value from the genetical standpoint and will in all probability lay bare the real foundation in fact of the so-called mutation hypothesis of De Vries.

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THE OHIO ACADEMY OF SCIENCE

THE twenty-third annual meeting of the [illegible] Academy of Science was held at Oberlin Col[illegible] Oberlin, Ohio, on November 27, 28 and 29, [illegible] the presidency of Professor L. B. Walto[illegible] Kenyon College.

address of the President was delivered Friday afternoon, on the subject "The Evolutionary Control of Organisms, and its Significance"; and Friday evening Professor Dayton C. Miller, of Case School of Applied Science, gave an illustrated lecture on "Sound."

There was an informal gathering of members in the Park Hotel on Thursday evening, and a reception in the Men's Building Friday evening, following the lecture. At the dinner Friday evening, held in the Park Hotel, the Academy was welcomed by President Henry C. King, of Oberlin College.

The arrangements of the local committee were very complete, and the meeting was in every way a very successful one.

The trustees of the research fund announced a further gift of $250 from Mr. Emerson E. McMillin, of New York City, for the encouragement of the research work of the academy. During the past year grants from the research fund have been paid to Clara G. Mark, Alfred Dachnowski, Charles Brookover, Freda Detmers and Stephen R. Williams.

Thirty-five members were elected, making the total membership of the Academy 239.

Officers for the ensuing year were elected as follows:

President—Professor T. C. Mendenhall, Ravenna.

Vice-presidents—(Zoology) Professor Stephen R. Williams, Miami University, Oxford; (Botany) Professor E. L. Fullmer, Baldwin-Wallace College, Berea; (Geology) Professor N. M. Fenneman, University of Cincinnati, Cincinnati; (Physics) Professor A. D. Cole, Ohio State University, Columbus.

Secretary—Professor Edward L. Rice, Ohio Wesleyan University, Delaware.

Treasurer—Professor J. S. Hine, Ohio State University, Columbus.

Librarian—Professor W. C. Mills, Ohio State University, Columbus.

Executive Committee—Professor Frank Carney, Denison University, Granville, and Professor L. B. Walton, Kenyon College, Gambier, to serve with the president, secretary and treasurer, members *ex officio*.

Publication Committee—Professor Charles H. [illegible]e, Hamilton, to serve with the hold-over members: Professor J. H. Schaffner, Ohio State University, Columbus, and Professor C. G. Shatzer, Wittenberg College, Springfield.

Trustees of Research Fund—Professor M. M. Metcalf, Oberlin College, Oberlin, to serve with the hold-over members: Professor William R. Lazenby, Ohio State University, Columbus, and Professor Edward L. Rice, Ohio Wesleyan University, Delaware.

The complete program follows:

"Plum Creek as a Glacial Chronometer," by G. Frederick Wright.

"Hybridization, Variability and Size," by L. B. Walton.

"Marengo Cave," by W. N. Speckman.

"A Statistical Study of the Physical Measurements of a Class of Students," by Carl J. West.

"The Effect of the Eruption of Katmi on Vegetation," by Robert F. Griggs.

"The Structure of a Fossil Starfish from the Upper Richmond," by Stephen R. Williams.

"With the International Phytogeographic Excursion in America," by A. Dachnowski.

"Comparison of the Mollusk Faunas of the Palæarctic and Nearctic Provinces," by V. Sterki.

"Flood and Drainage Conditions in Vicinity of Bellevue, Ohio," by George D. Hubbard.

"The Species Concept as Applied to the Genus *Pyrosoma*," by Maynard M. Metcalf.

"Geographic Influences in the History of Milan, Ohio," by C. G. Shatzer.

"The Acclimatization of Trees and Shrubs," by William R. Lazenby.

"The Life History of *Euglena*," by Charles G. Rogers.

"Botanical Observations in Alaska," by Robert F. Griggs.

"Conjugation in *Amœba*," by Ralph E. Hedges.

"Variation in *Scirpus atrovirens* and *S. georgianus*," by F. O. Grover.

"Notes on the Metamorphosis of Two Ascidians," by R. A. Budington.

"The Effect of Variation of Intensity and Duration of Stimuli to Reaction Time," by G. R. Wells.

"Pressure Sensation and the Hair Follicle," by R. H. Stetson.

"Further Notes on Embryonic Skull of *Eumeces*," by Edward L. Rice.

"An Addition to the Odonata of Ohio," by Rees Philpott.

"The Box-Elder Bug, *Leptocoris trivittatus*, in Ohio," by W. J. Kostir.

"An Occurrence of *Atypus milberti* Walck, in Ohio," by Carl J. Drake.

"Remarks on the Distribution of Certain Species of Jassidæ," by Herbert Osborn.

"Observations on the Action of the Heart in Mollusca," by V. Sterki.

"Chromosomes in *Opalina*," by Maynard M. Metcalf.

"The Cerebral Ganglia of an Embryo Salamander, *Plethodon glutinosus*," by W. J. Kostir.

"Report on the Work done with the Mollusk Fauna of Ohio," by V. Sterki.

"Some Additional Records for Ohio Mammals," by James S. Hine.

"Notes on the Cheese Skipper, *Piophila casei*," by Don C. Mote.

"The Distribution and Abundance of Some Animal Parasites of Ohio Live Stock," by Don C. Mote.

"The Ecology of Fishing Point, Pelee Island," by Lynds Jones.

"Migration Phenomena in the Sandusky Region," by Lynds Jones.

"The California Tarweed Industry," by Charles P. Fox.

"A Provisional Arrangement of the Ascomycetes of Ohio," by Bruce Fink.

"The Sprouting of the Two Seeds of a Cocklebur," by John H. Schaffner.

"Additions to the State Flora, presenting Two Species of Isoetaceæ from Portage County," by L. S. Hopkins.

"Notes on a Typical Ohio Woodlot," by William R. Lazenby.

"Ecological Varieties as illustrated by *Salix interior*," by John H. Schaffner.

"Certain Peculiarities of the *Botrychia*," by L. S. Hopkins.

"A New Variety of *Carex tribuloides*, with Notes on the Variability of the Species," by F. O. Grover.

"The Behavior of Some Species on the Edges of their Ranges," by Robert F. Griggs.

"The Catalog of Ohio Vascular Plants," by John H. Schaffner.

"A New Method in Lichen Taxonomy," by Bruce Fink.

"Additional Information on the Ohio Devonian," by C. R. Stauffer.

"Some Geological Features in the Newark and Frazeysburg Quadrangles," by G. F. Lamb.

"The Stratigraphy of the Upper Richmond Beds of the Cincinnati," by W. H. Shideler.

"Metamorphism in the Ordovician System of Giles County, Va.," by E. P. Rothrock.

"Evidence of Basining and Folding during the Eopaleozoic of the Southern Appalachians," by P. H. Cary.

"An Ancient Finger Lake in Ohio with Tilted Shorelines," by George D. Hubbard.

"Unconformity and Basal Conglomerates of the Mississipian Age in the Wooster Quadr. by G. F. Lamb.

"Methods of Mapping the Shorelines of Glacial Lakes," by Frank Carney.

"An Eroded Channel in the Cleveland Formation," by W. G. Burroughs.

"The Transparency of Various Substances for Infra-Red Radiation obtained by Focal Isolation," by Alfred D. Cole.

"Note on the Electrical Conductivity of Glass," by Robert F. Earhart.

"The Villari Reversal Effect in Ferro-Magnetic Substances,' by S. R. Williams.

"On the Longitudinal Thermo-Magnetic Potential Difference," by A. W. Smith.

"The Spectrum of Silicon in the Carbon Arc," by C. D. Coons.

"On the Vibrations of a Lecher System using a Lecher Oscillator," by F. C. Blake and Charles Sheard.

"The Wiedemann Effect in Monel and Nichrome Wires," by H. H. Reighley.

Symposium: The Quantum Theory of Matter and Energy.

I. "The Quantum Theory applied to Black Body Radiation," by E. J. Moore.

II. "The Quantum Theory applied to the Determination of the Specific Heat of Solid Bodies," by Charles Sheard.

III. "The Quantum Theory applied to Photoelectric and Thermionic Emission," by S. J. M. Allen.

IV. Title to be announced, by Clark W. Chamberlain.

V. General Discussion.

DEMONSTRATIONS

Rare Minerals from Rhodesia, by George D. Hubbard.

Alaskan Plants, by Robert F. Griggs.

Specimens illustrating California Tarweed Industry, by Charles P. Fox.

Specimens of Mollusca, by V. Sterki.

Ohio Odonata, by Rees Philpott.

Chromosomes of *Opalina*, by Maynard M. Metcalf.

Herbarium Specimens of *Scirpus* and *Carex*, b F. O. Grover.

Model of Embryonic Skull of *Eumeces*, by Edward L. Rice.

EDWARD L. RICE, Secretary

OHIO WESLEYAN UNIVERSITY,
DELAWARE, OHIO,
December 3, 1913

.E AMERICAN PHYSICAL SOCIETY

.HE regular Thanksgiving meeting of the Phys- l Society was held in Ryerson Physical Labora- ory, University of Chicago, on Friday and Saturday, November 28 and 29, 1913. The program was as follows:

Friday Afternoon

"Quantum Theory and Radiation," by C. E. Mendenhall.

"Quantum Theory and Photoelectric Effect," by R. A. Millikan.

"Quantum Theory and Statistical Mechanics," by Max Mason.

"Quantum Theory and Atomic Structure," by Jacob Kunz.

"Quantum Theory and Specific Heats," by A. C. Lunn.

Saturday

"The Relation between Photo-potentials and Frequency," by W. H. Kadesch.

"A Study of Contact P.D.'s between Metal Surfaces Prepared in Vacuo; the Effect of Ultraviolet Light upon these P.D.'s; and the Mutual Relation between Positive Potential and Contact P.D.'s," by Albert E. Henning.

"Anomalous Temperature Effects upon Magnetized Steel," by N. H. Williams.

"Experimental Determination of the Earth's Rigidity," by A. A. Michelson.

"A New Maximum in the Wave-length sensibility Curves of Selenium," by F. C. Brown and L. P. Sieg.

"Evidence of a Diurnally Reversing Convectional Circulation of the Atmosphere Over the Upper Peninsula of Michigan," by Eric R. Miller. (By title.)

"Polarization of Long-wave Infra-red Radiation by Wire Gratings," by A. D. Cole.

"Glow Discharge in a Magnetic Field," by R. F. Earhart.

"A Polarization Spectrophotometer Using the Brace Prism," by Harvey B. Lemon.

"Certain Experiments in Sound Diffraction," by G. W. Stewart and Harold Stiles.

"Effect of Space Charge and Residual Gases on the Thermionic Current in High Vacuum," by Irving Langmuir.

"Arrival Curves with Artificial Long Lines," Carl Kinsley.

"An Attempt at an Electromagnetic Emission ...ory of Light," by Jacob Kunz.

"Theory and Use of the Molecular Gauge," by Saul Dushman.

"A Modified Method of Measuring e/m ... for Cathode Rays," by L. T. Jones.

"An Experimental Determination of the Correction to the Law of Stokes for Falling Bodies, and of the Value of the Elementary Charge e," by John Y. Lee.

"On the Coefficient of Slip Between a Gas and a Liquid or Solid," by R. A. Millikan.

"Note on the Electron Atmospheres (?)," by Carl R. England.

"Vapor Pressure of Molybdenum and Platinum," by Irving Langmuir.

"Disappearance of Gas or Clean-up Effect in Vacuum Tubes," by Irving Langmuir.

"A New Principle in the Application of Selenium to Photometry," by F. C. Brown and L. P. Sieg.

"Determination of *e/m* from Measurements of Thermionic Currents," by Saul Dushman.

"Rate of Decay of Phosphorescence at Low Temperatures," by E. H. Kennard.

"Determination of the Sun's Temperature," by G. A. Shook.

"The Theory of Photoelectric and Photochemical Effects," by O. W. Richardson.

"Photoelectric Potentials of Cathode Films," by P. H. Dike.

"The Temperature Coefficient of Young's Modulus of an Iron Wire," by H. L. Dodge.

"The Temperature Distribution in an Incandescent Lamp Filament near a Cooling Junction," by A. G. Worthing.

"Further Experiments on Magnetization by Angular Acceleration," by S. J. Barnett.

"Production of Gases in Vacuum Tubes," by G. Winchester.

"A Precision Relay," by Carl Kinsley.

"A Thermopile of Bismuth-alloy," by W. W. Coblentz. (By title.)

A. D. COLE,
Secretary

THE CONVOCATION WEEK MEETING OF SCIENTIFIC SOCIETIES

THE American Association for the Advancement of Science and the national scientific societies named below will meet at Atlanta, Ga., during convocation week, beginning on December 29, 1913.